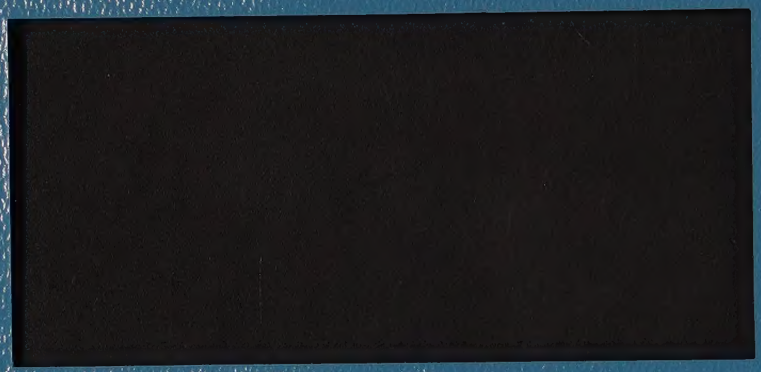
ITHACA N.Y.



INSTRUCTION & MAINTENANCE MANUAL

ITHACO MODEL 353

ITHACO, Inc.
735 West Clinton Street
Ithaca, New York 14850
607-272-7640

TABLE OF CONTENTS

Introduction 1

Specifications 2

Operating Instructions 3

- Power & Grounding 3
- Connections 4
- Preliminary Settings 5
- Operating Procedure 6
- High Frequency Operations 8
- Rejection of Odd Harmonics 8

Functional Description 10

Circuit Description 11

- Type B1 Amplifier 11
  - Amplifier Gain Switching 11
  - Dynamic Range 12
  - Input Stage 12
  - Filter Insertion Point 15
  - Remote Preamplifier 16
  - Power Supply 16
- Type C1 Demodulator 16
  - Demodulator Switches 16
  - Phase Shifter - General 18
  - Threshold Reference Detector 19
  - Input Multivibrator 19
  - Servo For 50% Duty-Cycle 19
  - Phase Shifters 20
  - Output Multivibrator 20
  - Second-Harmonic Operation 21

Circuit Description (Continued)

Display Module 21

Post Amplifier 21
Power Supply 23
Panel Meter Switching 23

Test & Calibration 24

Display Module 24
Type B1 Amplifier 28
Type C1 Demodulator 31
Basic System 33

Drawings

	ELEM	ASSY
D1 Module	D40547	D40351
A1 Card	D40538	D40539
A2 Card	C30586	C30778
Wiring Diag.	D40344	
B1 Module	D40401	C30610
A1 Card	D40398	D40358
C1 Module	D40356	C30600
A1 Card	D40330	D40334
A2 Card	D40330	C30788
Rack	C30650	C30547
System Block Diag.	D40444	

INTRODUCTION

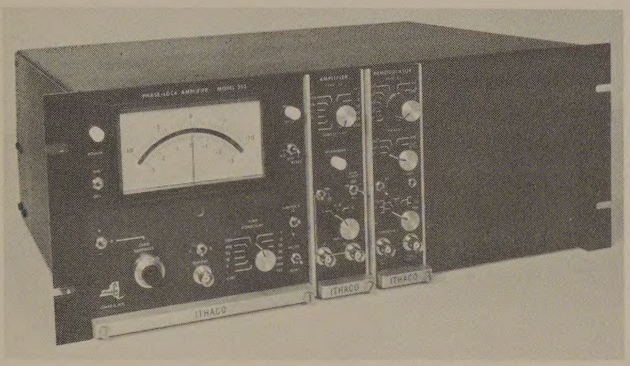
The 353 phase-lock amplifier utilizes the principle of synchronous detection to obtain very narrow effective bandwidths and hence high noise rejection without tuned circuits. It detects the average value of the signal at the frequency and phase of an external reference signal to which the instrument is synchronized. To accomplish this, the noise + signal input, after suitable amplification, is applied to a pair of full-wave demodulator switches operated by the reference signal. The d-c average of this result, obtained by putting it through a low-pass filter, is then directly proportional to the average value of the desired signal. The effective noise bandwidth of the system is determined by this low-pass filter, and can be made much narrower than is practicable by using any form of conventional bandpass filter.

This manual describes the basic 353 system, which consists of the following components: a Type B1 Amplifier, to provide signal amplification; a Type C1 Demodulator, which contains both the synchronous switches and the reference signal phase-shifter; and a Display Module, incorporating both the system power supply and the post-detection amplifier, including its panel meter. These three modules are plugged into a 350S1 Rack Frame, which automatically provides the required interconnections.

ITHACO INC.

735 W. CLINTON ST., ITHACA, N.Y. 14850 — 607-272-7640

MODEL 353 PHASE-LOCK AMPLIFIER



APPLICATIONS

- NMR
- BIO-PHYSICS
- PHOTOMETRY
- BIOCHEMISTRY
- SPECTROSCOPY
- MAGNETOMETERS
- EPR
- BIOMEDICINE
- OPTICAL STUDIES
- INFRARED STUDIES
- A-C POLAROGRAPHY
- INFRARED ASTRONOMY
- ELECTRO CHEMISTRY

The Model 353 Phase-Lock Amplifier is an instrument used to detect repetitive signals in the presence of noise. Its output is a DC level proportional to the average value of the input signal at the frequency and phase of a reference signal to which the instrument is synchronized. The effective passband is extremely narrow and centered at the reference frequency.

A reference signal within a selected decade of the 1 Hz to 200 KHz frequency range is automatically accommodated without the fine-frequency tuning required by conventional lock-in amplifiers. This avoids severe phase and gain instability when the reference frequency varies. Overload will not occur with peak to peak non-coherent input signals of 1000 times the full-scale signal setting. This feature eliminates the need for predetection filtering in a majority of applications.

The 353 is easy to use, and does not require the tedious set-up and calibration of equivalent instruments. Modular in construction, it can be adapted to a wide variety of applications at minimum cost and size. It utilizes the latest in solid state analog technology to achieve unmatched accuracy, stability and dependability.

Consult the factory for information on remote and transformer input preamplifiers. Additional specialized plug-ins will be released in the future. In addition, blank plug-ins are available to accommodate user circuitry -- transducer conditioning, etc.

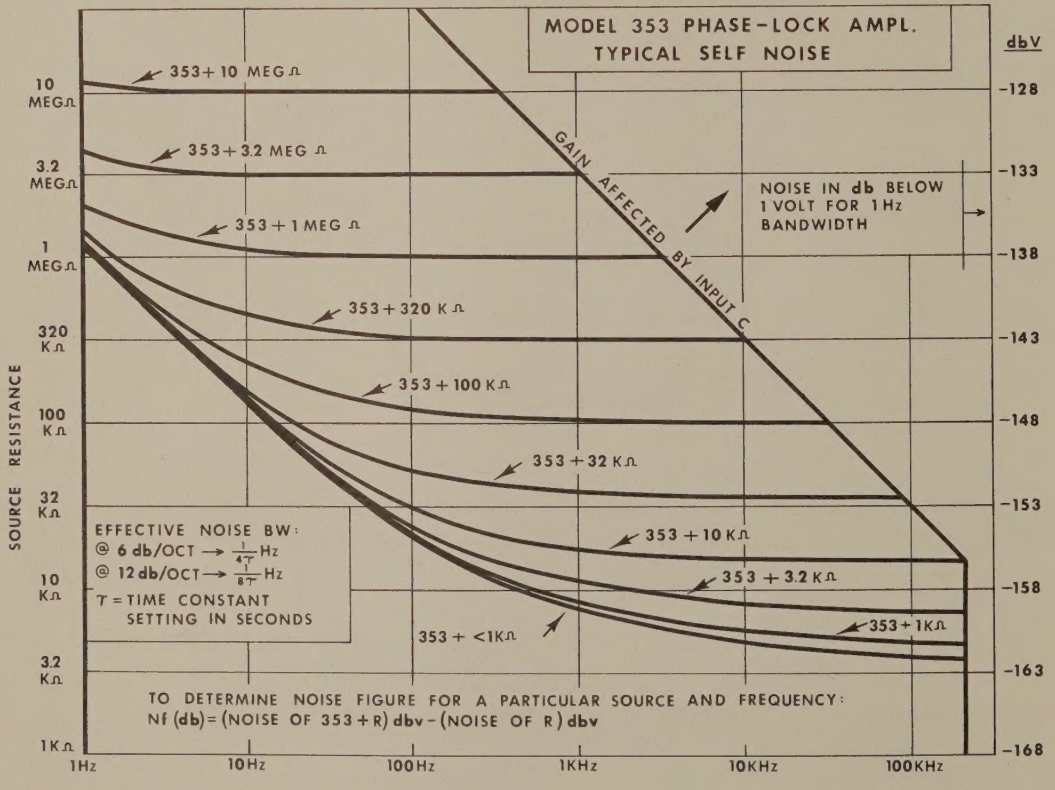
SPECIFICATIONS

FREQUENCY RANGE	1 Hz (-2db) to 200 KHz (-4db) in 5 ranges. No frequency tuning required within a given range.
SENSITIVITY *	1μv to 300 mv for 10 volt output (post detection gain = 1000) 100μv to 3v (post detection gain = 10)
ACCURACY	±5%
GAIN STABILITY	±.1% per 24 hours, .05% per °C
INPUT	Differential input impedance 300 megohm shunted by 30 pf
COMMON MODE REJECTION RATIO	60 db, dc to 10 KHz
OVERLOAD *	Will accommodate peak to peak non-coherent input signals of 3 volts or: 1000 times the full scale sensitivity setting (post detection gain = 1000) 10 times the full scale sensitivity setting (post detection gain = 10)
OUTPUTS	1) ±10 volts full scale into 3K ohm load, front and rear panel BNC connectors 2) Adjustable 0-1 volt full scale, rear panel BNC recorder output
OUTPUT DRIFT *	.1% of full scale/24 hrs, .05% of full scale/°C (post detection gain = 1000) .001% of full scale/24 hrs, .0005% of full scale/°C (post detection gain = 10)

SPECIFICATIONS (CONTINUED)

ZERO SUPPRESS *	Calibrated 0 to 1000% of full scale. Accuracy ±3% of setting. Stability ±.01% of setting per 8 hours, ±.01% per degree C. Zero suppress has no effect on dynamic range or overload capability.
EQUIVALENT NOISE BANDWIDTH	.0005 Hz to 250 Hz
POST DETECTION FILTER *	Time constant 1.0 msec to 300 sec ±10%, in 1, 3, 10 sequence, 6 or 12 db/octave rolloff (post detection gain = 1000) 1.0 msec to 30 sec, 6 db/octave rolloff (post detection gain = 10)
REFERENCE INPUT	100 mv to 20 volts peak to peak, any waveform with rms value above 40 mv, input impedance 5 megohms.
PHASE SHIFT	0 - 180° continuous control and 0°, 90°, 180°, 270° steps. Continuous control accurate to ±5°. Quadrature switch accuracy between 90° steps is ±3°. At high frequencies, phase accuracy limited to ±.3μsec.
2ND HARMONIC MODE	Front panel switch permits automatic detection of 2nd harmonic. Minimum rejection of fundamental is 60db.
POWER	110/220v, 50-400 Hz
MECHANICAL	7" high, 19" wide, 14" deep, fits standard 19" relay rack. Modular in construction, accommodates up to 3 additional plug-ins. Wt: Approx. 30 lbs

*A rear panel switch selects post detection gain of 1000 or 10. The zero suppress range is ±10% of full scale in the 10 position.



UNIT PRICE

MODEL 353 PHASE - LOCK AMPLIFIER	$1590.00

This price includes the rack adapter and 3 plug-in modules.
Unit prices for individual plug-ins available upon request.

BLANK PLUG-IN, MODEL Z1	$ 40.00

Prices are FOB destination within continental United States and are subject to change without notice. Terms of sale are net 30 days. Copies of ITHACO twelve month warranty are available upon request.

Printed in USA

OPERATING INSTRUCTIONS

General

This section summarizes the steps necessary to set up and operate the 353. Other sections of this manual should be consulted for detailed information on performance limits, ranges of operating controls, input and output impedances, etc.

The basic 353 consists of the following items:

Type B1 Amplifier	Display Module
Type C1 Demodulator	Rack Frame

The Display module must be inserted into the left-hand end of the Rack Frame, in order to make proper electrical connections to the bus structure. The B1 and C1 modules should be inserted into the positions immediately adjacent to the Display Module. It is generally more convenient for the C1 to be next to the Display.

Power & Grounding

A standard 3-wire line cord and plug is provided with the grounding (green) wire permanently connected to the case of the 353.

The signal ground circuit of the 353 is normally connected to the Rack Frame ground (and thus to the a-c line ground) by means of a shorting link located at the left rear exterior of the Rack Frame. To isolate signal ground from a-c line ground, remove this link. The individual plug-in's (with the exception of the Display Plug-in) are isolated from the rack frame and are connected to signal ground inside each plug-in.

The shells of the BNC connectors used for the "A" and "B" inputs of the Type B1 Amplifier are connected to signal ground only via front panel toggle switch on the B1 amplifier.

It is vitally important, particularly when making low level or high frequency measurements, to make proper ground connections to external equipment, particularly those associated with the signal and reference inputs.

It is usually good practice to; a) connect the ground link on rear of 353 b) float all auxilliary equipment such as oscilloscopes, recorders, voltmeters, oscillator, etc from the AC line by means of "cheater" plugs. c) have the B1 ground switch "ON".

If possible, the signal source and reference source grounds should be isolated from each other except at the 353.

Connections

a) Power and Grounds - see previous paragraph

b) Signal. Signal-ended sources can be connected to either the A or B input. Balanced sources can be connected for differential operation either by:

1) two coaxial cables to the "A" and "B" input (with ground switch "ON"), or

2) With the ground switch "OFF" either the "A" or "B" input becomes a differential input, with the shell of the BNC carrying one of the signals. This facilitates differential operation with a single input cable.

c) Reference. The signal to which the instrument is to be synchronized should be connected to "REF IN" on the front panel of the C1 module. See specifications for allowable range of signal level, input impedance, etc.

d) Output. If it is desired to use an auxiliary meter or recorder in addition to the panel meter provided, it may be connected to either the front panel or the rear-panel BNC connector, labeled "OUTPUT", on the Display Module. If the front-panel connector is used, make certain that the adjacent switch is in the "1" position. A 0-1 volt full scale recorder output it also available on the rear panel.

Preliminary Settings

The following checklist of initial settings may be useful in setting up the instrument. It will serve as a point of departure from which future changes can be made. Also, if at any subsequent time the desired output signal is not obtained, an inspection of the control panels should be made to determine whether a switch has inadvertently been operated.

a) Display Module

POWER - ON; pilot lighted.

ZERO SUPPRESS - multi-turn control at 0, adjacent toggle switch at 0.

OUTPUT switch at 1.

TIME CONSTANT switch at 1 SEC.

METER switch at SIG.

db/OCT switch at 12.

Post Detection Gain (rear panel) at 1000

b) Demodulator Type C1:

PHASE controls (continuous and quadrature) both at 0^{o}

f/2f switch at f.

FREQUENCY RANGE switch in accordance with reference frequency being used. Note: there is an overlap of approximately 30 percent on the ranges shown.

c) Amplifier Type B1:

SENSITIVITY - It will be found convenient to set this switch initially for a signal somewhat larger than that anticipated, and subsequently reduce the setting.

Input selector switch - Select A or B for single ended operation, A-B for differential. See "connections" above.

Grounding switch in ON position

Low limit at 1 hz.

FILTER insertion jacks, (rear panel). An internal jumper obviates need for an external cable, unless a filter is to be used, in which case the factory must be consulted. If this jumper is removed the connection must be made externally with a short BNC cable.

Operation Procedure

a) Reference Check. Operate METER switch to reset and then release. The switch will spring-return to the REF position. The pointer should move toward right-hand end of scale and then return gradually to an indication at or very near positive half-scale, and remain steadily in this position. This reading shows that the demodulator circuitry is properly acquiring and processing the applied reference signal. Return METER switch to SIG. This confidence check should be performed following connection or interruption of the reference signal, or whenever power is turned on.

b) Signal Acquisition. If a useable deflection is not obtained on the panel meter, rotate SENSITIVITY control counterclockwise, one step at a time.

The overload lamps on both the B1 and Display modules may light up, because of switching transients. If they remain continuously lighted, the noise and/or signal level is greater than the linear capability of the machine. In this event, either the sensitivity setting must be reduced, or steps taken to reduce the noise at the input of the instrument.

The B1 amplifier output signal may be monitored via the OUTPUT BNC on the rear panel. At this point, a signal of 10mv average value will produce full scale at the instrument output*.

For best performance, the instrument should always be used at the highest sensitivity setting (highest gain) possible consistent with the 10-volt output dynamic range.

If desired, the customer may install passive signal-conditioning or filter elements at the amplifier input, as indicated on the Elementary Diagram D40398.

c) Phase Adjustment. Normally, the phase should be adjusted to yield maximum output signal.

A more exact setting (for sine wave input) will result if at first the controls are adjusted for a null at the output, and then the quadrature phase control is indexed 90^{o} in either direction.

The detected signal prior to filtering and post-amplification can

be observed at a BNC marked "DET" on the rear panel of the C1 module. The full scale at this point is 10 mv.

The OUT position of the quadrature switch by-passes the phase controls and permits detection at the phase and duty cycle of the external reference signal.

d) Time Constant Setting. The panel markings of this switch represent the time-constants of each two electrically isolated low-pass filter sections in tandem. The composite effect is that the response to a step function will be approximately 60% of final amplitude in twice the labeled time constant.*

An intermediate value of time constant will be found most convenient during initial settings of phase and sensitivity controls. Longer time constants introduce delays in observing the effects of such changes. The ultimate setting of this control is usually a compromise between the amount of integration to be done by the instrument, and the amount to be performed by observation of the panel meter or a recorder.

The spring return RESET position of the FILTER switch is useful for discharging the time-constant capacitors.

It is usually desirable to employ both sections of the post-detection filter (i.e., switch in the 12 db/OCT position). The equivalent noise bandwidth of a single section is 1/4 RC cycles, where RC is the time constant is indicated by the panel marking of the selector switch. For two sections, the bandwidth is exactly one-half the former value, or 1/8 RC. However, the rise time (to 90%) for two sections is 3.4 RC, or only 1.55 times the value of 2.2 RC for a single section. On the other hand, stability considerations may require use of a single-section when the 353 is employed in a closed-loop system.

e) Calibration. The instrument calibration may be checked by connecting the CAL OUT to the "A" or "B" input. With the SENSITIVITY switch in the 10MV position, a full-scale meter deflection should result when the phase controls are properly adjusted.

The CAL OUT is provided primarily as a confidence check that the instrument is operating properly.

* See "Post Amplifier" section for discussion of the effects of the post detector gain switch on the rear of the display plug-in.

High Frequency Operation

When the Model 353 is used at frequencies above 10KHz, the following steps should be taken:

1) At frequencies approaching the high limit of the instrument, (50KHz-200KHz), amplitude and phase accuracy will be improved by using only the 45° to 180° range of the continuous phase control. This still permits the adjustment of the reference to any phase with respect to the signal through the use of the quadrature switch.

2) With reference connected and operating, set sensitivity to the 300mv level, select the "A" input, and cap the "A" input with a shorting plug. Remove any dc offset with the zero suppress, then lock the zero suppress control. No connections of any kind should be made to the B1 inputs during this adjustment.

3) Set sensitivity for the lowest expected signal level, and with the input still capped, connect the signal ground return to the BNC shell and observe that no significant deflection of the meter occurs. If it does, there is insufficient ground isolation between the signal and reference sources, and steps must be taken to achieve better isolation. It may be necessary to use an electrostatically shielded transformer on the reference input or a transformer-input pre-amplifier for the signal, if isolation cannot otherwise be achieved.

4) It is not recommended that the basic 353 be used above 10KHz at sensitivity settings below 10μv. Additional gain should be obtained through the use of an appropriate preamplifier.

Rejection of Odd Harmonics

The nature of the synchronous detector is such that odd harmonics in the signal presented to the detector are attenuated by an amount inversely proportional to the number of the harmonic. That is, the third harmonic is diminished by 1/3, the fifth by 1/5; etc. This is to say that side bands exist at these odd harmonic frequencies of the same bandwidth as the fundamental pass band (as determined by the post detection filter setting) and of the amplitude indicated above. With a gaussian noise input, the amount of noise contained in these side bands will add approximately 1 db to the noise at the output that would exist if these side bands were not present.

If substantial 60 cycle interference is present, it is important to choose a modulating frequency that is not harmonically related to 60Hz,

a requirement that can be relieved in part by predetection filtering of the 60Hz. Such filtering will be found to be unnecessary (unless it is of such magnitude as to overload the instrument) if an appropriate modulating frequency is chosen.

In particular, the use of a synchronous motor operated from the 60Hz line is to be discouraged for driving a chopper wheel modulator. Use an induction motor or a dc motor and you will almost surely have no difficulty. The induction motor is to be particularly recommended since they are inexpensive, and, unlike other lock-in instruments, the 353 will track any frequency drift that occurs.

FUNCTIONAL DESCRIPTION

Drawing D-40444 is a detailed block diagram showing the major elements of the instrument and the controls provided. A more extensive discussion is contained in the Circuit Description section of this manual.

The input signal is amplified in a fixed gain (10db) differential input stage, the output of which is amplified (or attenuated) and fed in balanced form to the demodulator switches.

The demodulator output passes through the first section of the selectable post detection filter to a fixed gain dc amplifier. The feedback circuit of this amplifier contains the 2nd section of this filter. This amplifier output is the instrument output.

The lower half of drawing shows the reference signal processing circuits. A series of monostable multivibrators convert the reference signal into a square wave, for controlling the demodulator switches, that is precisely 50% in duty cycle and phase shifted by the amount indicated by the front panel controls, regardless of frequency or reference signal waveform. A servo loop establishes the duty cycle of MV1 at exactly 50%. MV2 and MV3 are delay multivibrators that establish the phase shift. MV4 provides the square wave to the demodulator.

Overload is monitored at the only 3 places overload can occur- twice in the predetection amplifier, and once in the post detection amplifier. The alarm circuits are indicated on the drawing.

The instrument has an internal power supply that generates current-limited ±15 volt regulated voltages.

CIRCUIT DESCRIPTION

1. Type B1 Amplifier

General

The B1 serves as a pre-detection signal amplifier. Its principal function is to provide gain or attenuation, as may be required, for the signal from the customer's source; and to present this resulting signal in balanced form to the demodulator switches in the Type C1 module. It therefore has the following attributes:

a) Accommodation for either single-ended or differential input sources.

b) An optional means for attenuating possible ground-loop currents from these sources.

c) An input impedance which is uniformly high over the passband

d) Calibrated gain increments.

e) Insertion points for optional introduction, by the customer, of signal-conditioning networks and/or external filters.

f) Low noise and large dynamic range.

g) An overload lamp to indicate when the applied signal-plus-noise exceeds this dynamic range limit.

h) A connector for power and signal circuits for an optional remote preamplifier.

Amplifier Gain Switching

The front panel SENSITIVITY control S1 is calibrated in terms of the RMS value of input sine wave signal required to produce a 10-volt instrument output when the B1 is used in a complete 353 system. The corresponding full-scale output of the B1 module itself is single ended, signal having an average value of 10 millivolts.

The gain of the input stage (Q1-Q8, inclusive) is fixed at 3 times, and the gain of the output stage (IC2) is fixed at 33.3 times. Between these, and intermediate stage (IC1), having a fixed gain of 100 times, and an attenuator, S1B, are switched to provide the required overall gain. See Table I.

Dynamic Range

As a result of the above switching arrangement, and of the design of individual stages, the overload limit of the amplifier is that of its output stage, for settings of the SENSITIVITY control from 1 μv to 3 mv, inclusive. See last column of Table I.

To warn the operator of the presence of signals greater than the overload limit, an alarm circuit energizes a front-panel indicator lamp. This circuit, composed of Q13-Q15, is actuated by excess levels at either the output of the differential input stage, or the final output of the B1 amplifier. In order that overloads of short duration will attract the operator's attention, the circuit is designed to keep the lamp lighted for a brief period after it has been triggered.

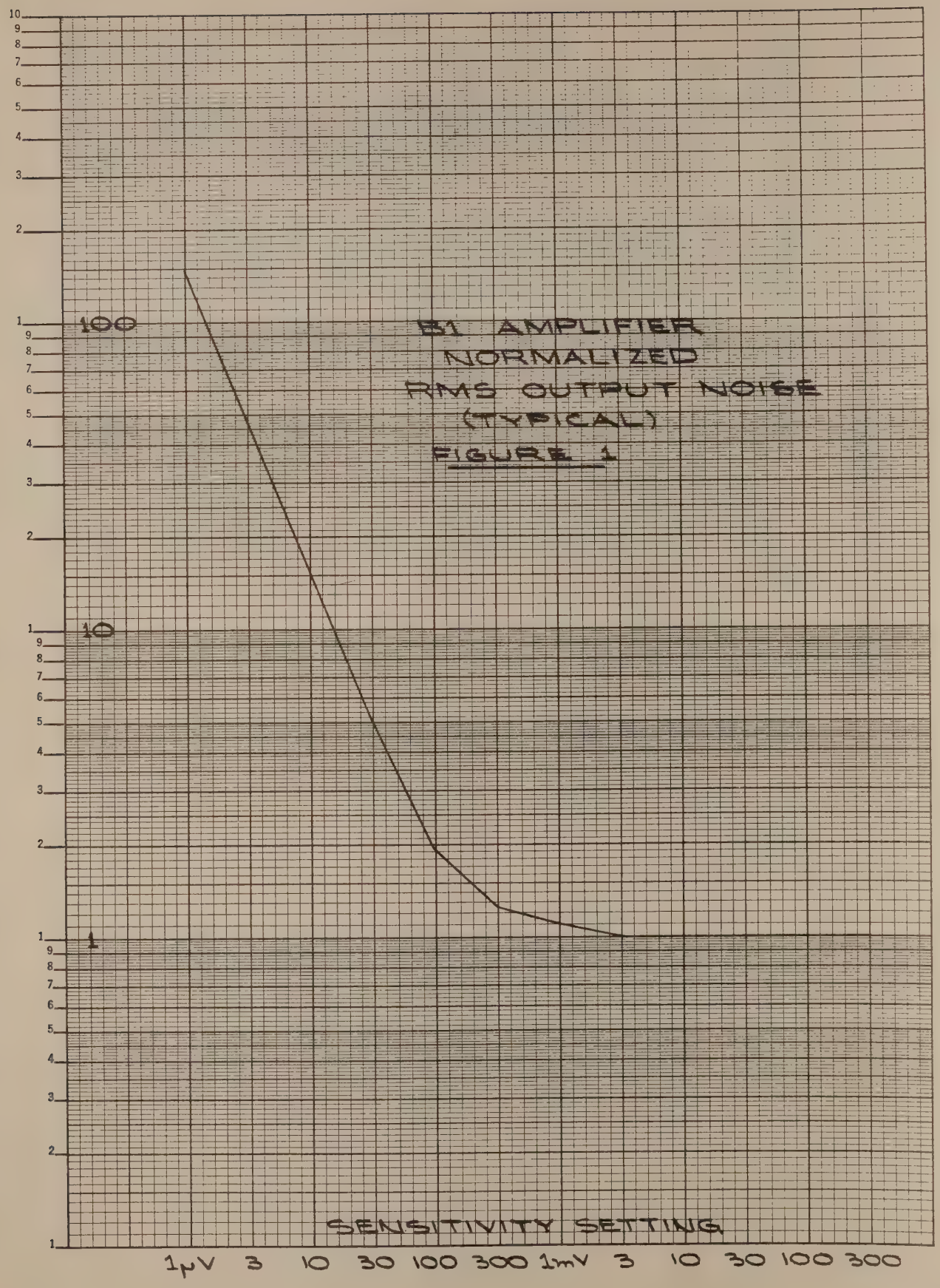
Input Stage (Q1-Q8, inclusive)

This is a low-noise differential amplifier, with gain stabilized at 3 times. The balance is adjusted by potentiometer R23 (located on the p-c card). The four FET's in this circuit have been selected for low noise and for specified zero-bias static current.

TABLE I - AMPLIFIER GAIN TABLE

S1 Dial	Input Gain	S1A-IC1 Gain	S1B Gain	IC2 Gain	Total Gain	Over-Load*
1 μv	3	100	1	33.3	10,000	1 mv
3	"	100	1/3	"	3,300	3
10	"	100	1/10	"	1,000	10
30	"	100	1/30	"	333	30
100	"	1	1	"	100	100
300	"	1	1/3	"	33.3	300
1 mv	"	1	1/10	"	10	1 v
3	"	1	1/30	"	3.3	3
10	"	1	1/100	"	1	5
30	"	1	1/300	"	1/3	5
100	"	1	1/1000	"	1/10	5
300	"	1	1/3000	"	1/30	5

*Peak-to-peak overload voltage referred to input


100
10
1
B1 AMPLIFIER
NORMALIZED
RMS OUTPUT NOISE
(TYPICAL)
FIGURE 1
SENSITIVITY SETTING
1μV 3 10 30 100 300 1mV 3 10 30 100 300

The self-noise of the amplifier, referred to its input, remains essentially constant for SENSITIVITY settings from 1 μv to 100μv. as shown in Figure 1.

The input stage is protected from transients exceeding the power supply voltages by diodes CR3-CR6, inclusive.

Bifurcated terminals E1-E6, inclusive, are provided on the p-c board to permit user-installation of signal conditioning components, such as Pi-or L-section RC networks. The physical location of these terminals is shown on assembly drawing D40358.

Filter Insertion Point

BNC connectors J5 and J6, located on the rear panel, are provided for the insertion of an external filter. As originally shipped, this module has a jumper wire soldered between the center terminals of the BNC connectors, as shown on the Elementary Diagram; this jumper must of course be cut if a filter is used.

If it should be desired to insert a filter at this point, either active or passive, it must have the following characteristics:

a) Input impedance of 25 Kohms or greater

b) Capable of driving a load impedance of 10 Kohms.

c) Dynamic range sufficient to handle the maximum expected noise-plus-signal at its input.

d) Self-noise sufficiently low with respect to the signal level at this point, which is 3 times higher than the input level.

e) Provide a direct connection between the shells of the two BNC connectors J5 and J6; this connection must be isolated from all other grounds.

f) Must have a DC path to ground from its output of no larger than 10K ohm.

Remote Preamplifier

An optional remote preamplifier, such as an ITHACO Model 143L, may be connected to the Cannon Type XLR connector on the rear panel. Pin numbers for power and signal circuits are shown on Elementary Diagram D40398. The input switch should be set to A, with the ground switch "off". Figure 2 shows a wiring diagram for the 143L.

Power Supply

Although the d-c power supplied from the Display Module to the B1 is voltage-regulated, further filtering is provided for the input and intermediate stages by L2, L3, and Q9-Q12. A "crowbar" type of protection against application of reversed supply polarity is furnished by diodes CR10 and CR11.

2. Type C1 Demodulator

General

The Type C1 contains the heart of the 353 system: the synchronously-operated demodulator switches. Also included in this module is the complete reference channel, which processes the reference signal into a waveform suitable for driving the gates of these switches. This processing includes threshold detection and amplification, conversion to a square wave of precisely 50% duty cycle, and phase-shifting by the desired amount; it further includes frequency-doubling when detection at the second harmonic of the signal frequency is desired.

Demodulator Switches

A balanced unity gain amplifier, AC coupled at its input and dc coupled at its 2 outputs (elementary diagram B40330) provides the inputs to the demodulator switches. The IC amplifier are especially selected for low noise and low offset drift.

A complementary pair of switches, Q40 and Q41, converts the balanced signal into a detected output. This latter is then filtered and amplifier by the post-amplifier located in the Display Module. These switching transistors are MOSFET's, which are characterized by zero offset voltage, high ratio of OFF/ON resistance, low input conductance, and low reverse capacitance.

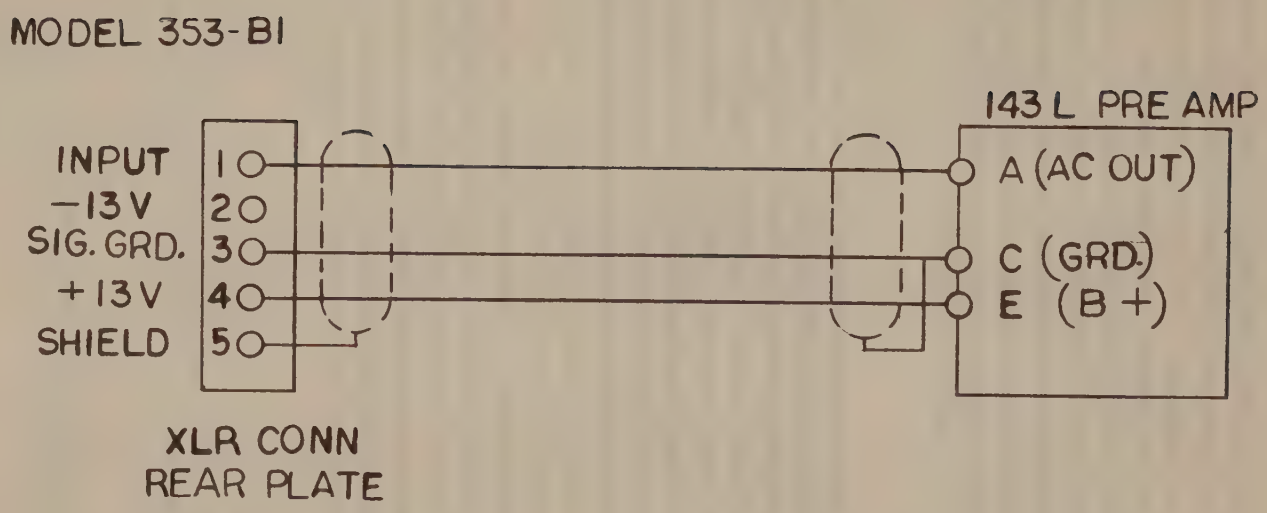

MODEL 353-B1
143 L PRE AMP
INPUT
−13 V
SIG. GRD.
+13 V
SHIELD
1
2
3
4
5
A (AC OUT)
C (GRD.)
E (B +)
XLR CONN
REAR PLATE

FIG. 2

The square-wave output of the reference channel drives the gates of the two MOSFET's. Since the latter are of opposite polarity, one conducts on the positive half of the gate waveform, and the other on the negative half, thus effecting full-wave synchronous detection.

A BNC connector on the rear panel, permits convenient observation of the signal waveform at the detector putput. The actual waveform being applied to the gates of the demodulator switches can be observed (after attenuation to 3 volts peak-to-peak) at the GATE OUT jack, J4.

Phase Shifter - General

Shifting of the phase of the reference signal by the desired angle is accomplished by digital techniques, rather than by analog methods. This avoids the requirement for a tuned reference amplifier, with the necessity for readjusting it for either frequency or amplitude changes. Also, a greater degree of precision and stability can be achieved by this method. Thc C1 will thus automatically accommodate reference signals having a wide variation in waveform and amplitude, and a frequency span greater than that of the specific decade range selected by S2.

The operation of the phase-shifter is best understood by reference to the Functional Block Diagram D40444. After limiting and squaring by the Threshold Detector and the monostable multivibrator MV1, the resulting square waveform of reference signal is fine phase-shifted by MV2, and quadrature phase-shifted by MV3, respectively. In either

case, the desired amount of phase shift is called for by an adjustable d-c bias voltage applied to the timing network of the multivibrator.

In order that the phase shift thus produced will be independent of frequency (within the decade range selected by the front panel control), a servo control signal is applied to the timing circuit of each multivibrator. This signal is derived from a closed-loop servo system which maintains the duty-cycle of the MV1 output at precisely 50%.

A detailed description of the Reference Channel circuitry follows:

Threshold Reference Detector

The reference channel will automatically accept waveforms having a wide range of amplitude - from 100 mv to 20v peak-to-peak without need for an adjustable attenuator. This is accomplished by threshold detector IC1, an operational amplifier with positive feedback; and by diode limiters CR5 and CR6, buffered by Q10. Note that an effect of the diode limiters is to reduce the input impedance at J1 from 5 meg. to about 10K, for input waveforms greater than approximately 6 volts peak-to-peak. The offset of the threshold detector is adjusted by R30, located on the p-c card (see Assembly Drawing D40344).

Input Multivibrator, MV1

The output signal from the Threshold Detector, after further limiting by Zener diode CR10, is regenerated by MV1 into a square wave of precisely 50% duty-cycle. This monostable multivibrator is composed of Q32-Q37, inclusive.

Precise control of the recovery time of MV1, and thus of its output duty-cycle, is accomplished by a servo voltage ("A", on the Elementary Diagram) applied to the base of Q36, a current source in the timing network. This servo is discussed in the next section.

The output of MV1 is also used, via an attenuator adjustable by R106 (on p-c card), to provide a square waveform of 20 millivolts peak-to-peak, at the CAL OUT jack, J2.

Servo For 50% Duty-Cycle

This servo, consisting of Q1-Q8, inclusive, is responsive to the duty-cycle at the output of MV1, and maintains this duty-cycle at precisely 50% by applying the aforementioned feedback voltage "A" to this multivibrator. This same voltage is applied also to the three other multivibrators, and furthermore is externally available for the control of optional accessory modules via the bus system.

The square-wave output of the reference channel drives the gates of the two MOSFET's. Since the latter are of opposite polarity, one conducts on the positive half of the gate waveform, and the other on the negative half, thus effecting full-wave synchronous detection.

A BNC connector on the rear panel, permits convenient observation of the signal waveform at the detector putput. The actual waveform being applied to the gates of the demodulator switches can be observed (after attenuation to 3 volts peak-to-peak) at the GATE OUT jack, J4.

Phase Shifter - General

Shifting of the phase of the reference signal by the desired angle is accomplished by digital techniques, rather than by analog methods. This avoids the requirement for a tuned reference amplifier, with the necessity for readjusting it for either frequency or amplitude changes. Also, a greater degree of precision and stability can be achieved by this method. Thc C1 will thus automatically accommodate reference signals having a wide variation in waveform and amplitude, and a frequency span greater than that of the specific decade range selected by S2.

The operation of the phase-shifter is best understood by reference to the Functional Block Diagram D40444. After limiting and squaring by the Threshold Detector and the monostable multivibrator MV1, the resulting square waveform of reference signal is fine phase-shifted by MV2, and quadrature phase-shifted by MV3, respectively. In either

case, the desired amount of phase shift is called for by an adjustable d-c bias voltage applied to the timing network of the multivibrator.

In order that the phase shift thus produced will be independent of frequency (within the decade range selected by the front panel control), a servo control signal is applied to the timing circuit of each multivibrator. This signal is derived from a closed-loop servo system which maintains the duty-cycle of the MV1 output at precisely 50%.

A detailed description of the Reference Channel circuitry follows:

Threshold Reference Detector

The reference channel will automatically accept waveforms having a wide range of amplitude - from 100 mv to 20v peak-to-peak without need for an adjustable attenuator. This is accomplished by threshold detector IC1, an operational amplifier with positive feedback; and by diode limiters CR5 and CR6, buffered by Q10. Note that an effect of the diode limiters is to reduce the input impedance at J1 from 5 meg. to about 10K, for input waveforms greater than approximately 6 volts peak-to-peak. The offset of the threshold detector is adjusted by R30, located on the p-c card (see Assembly Drawing D40344).

Input Multivibrator, MV1

The output signal from the Threshold Detector, after further limiting by Zener diode CR10, is regenerated by MV1 into a square wave of precisely 50% duty-cycle. This monostable multivibrator is composed of Q32-Q37, inclusive.

Precise control of the recovery time of MV1, and thus of its output duty-cycle, is accomplished by a servo voltage ("A", on the Elementary Diagram) applied to the base of Q36, a current source in the timing network. This servo is discussed in the next section.

The output of MV1 is also used, via an attenuator adjustable by R106 (on p-c card), to provide a square waveform of 20 millivolts peak-to-peak, at the CAL OUT jack, J2.

Servo For 50% Duty-Cycle

This servo, consisting of Q1-Q8, inclusive, is responsive to the duty-cycle at the output of MV1, and maintains this duty-cycle at precisely 50% by applying the aforementioned feedback voltage "A" to this multivibrator. This same voltage is applied also to the three other multivibrators, and furthermore is externally available for the control of optional accessory modules via the bus system.

The square-wave output of the reference channel drives the gates of the two MOSFET's. Since the latter are of opposite polarity, one conducts on the positive half of the gate waveform, and the other on the negative half, thus effecting full-wave synchronous detection.

A BNC connector on the rear panel, permits convenient observation of the signal waveform at the detector putput. The actual waveform being applied to the gates of the demodulator switches can be observed (after attenuation to 3 volts peak-to-peak) at the GATE OUT jack, J4.

Phase Shifter - General

Shifting of the phase of the reference signal by the desired angle is accomplished by digital techniques, rather than by analog methods. This avoids the requirement for a tuned reference amplifier, with the necessity for readjusting it for either frequency or amplitude changes. Also, a greater degree of precision and stability can be achieved by this method. Thc C1 will thus automatically accommodate reference signals having a wide variation in waveform and amplitude, and a frequency span greater than that of the specific decade range selected by S2.

The operation of the phase-shifter is best understood by reference to the Functional Block Diagram D40444. After limiting and squaring by the Threshold Detector and the monostable multivibrator MV1, the resulting square waveform of reference signal is fine phase-shifted by MV2, and quadrature phase-shifted by MV3, respectively. In either

case, the desired amount of phase shift is called for by an adjustable d-c bias voltage applied to the timing network of the multivibrator.

In order that the phase shift thus produced will be independent of frequency (within the decade range selected by the front panel control), a servo control signal is applied to the timing circuit of each multivibrator. This signal is derived from a closed-loop servo system which maintains the duty-cycle of the MV1 output at precisely 50%.

A detailed description of the Reference Channel circuitry follows:

Threshold Reference Detector

The reference channel will automatically accept waveforms having a wide range of amplitude - from 100 mv to 20v peak-to-peak without need for an adjustable attenuator. This is accomplished by threshold detector IC1, an operational amplifier with positive feedback; and by diode limiters CR5 and CR6, buffered by Q10. Note that an effect of the diode limiters is to reduce the input impedance at J1 from 5 meg. to about 10K, for input waveforms greater than approximately 6 volts peak-to-peak. The offset of the threshold detector is adjusted by R30, located on the p-c card (see Assembly Drawing D40344).

Input Multivibrator, MV1

The output signal from the Threshold Detector, after further limiting by Zener diode CR10, is regenerated by MV1 into a square wave of precisely 50% duty-cycle. This monostable multivibrator is composed of Q32-Q37, inclusive.

Precise control of the recovery time of MV1, and thus of its output duty-cycle, is accomplished by a servo voltage ("A", on the Elementary Diagram) applied to the base of Q36, a current source in the timing network. This servo is discussed in the next section.

The output of MV1 is also used, via an attenuator adjustable by R106 (on p-c card), to provide a square waveform of 20 millivolts peak-to-peak, at the CAL OUT jack, J2.

Servo For 50% Duty-Cycle

This servo, consisting of Q1-Q8, inclusive, is responsive to the duty-cycle at the output of MV1, and maintains this duty-cycle at precisely 50% by applying the aforementioned feedback voltage "A" to this multivibrator. This same voltage is applied also to the three other multivibrators, and furthermore is externally available for the control of optional accessory modules via the bus system.

The servo circuit detects the duty-cycle of the waveform applied to it by alternately charging and discharging capacitor C5 through two balanced current sources, Q4 and Q5 respectively. These in turn are switched by Q3 and Q2 at the start of each half-cycle. If the two current sources are exactly matched (by adjustment of R2, located on the rear panel), an applied signal having a duty-cycle of precisely 50% will not cause an accumulation of charge on C5.

The residual voltage on C5 is sampled by switch Q7 at the end of each cycle. This voltage is stored on C4, and is amplifier by Q8 to become the servo control voltage "A".

Although this servo is linear over a frequency range appreciably greater than the designated limits of the decade range selected by panel switch S2, it can "lock-up" at submultiplies of the reference signal. Therefore, a reset control is provided, which discharges capacitor C5. This switch and its associated components are physically located on the panel of the Display Module. It is labeled "SIG/REF/RESET. In the ref and reset positions, the panel meter is switched to monitor the average value of the output waveform of the reference channel. When the latter settles to 50% - half-scale on the meter, the servo has properly acquired the reference signal. Actuating the above reset switch will cause the 353 panel meter to move toward full-scale (positive) monemtarily, and then settle back to the 50% point.

Phase Shifters

Continuous and quadrature phase-shifting of the reference signal is accomplished by identical monostable multivibrators MV2 and MV3, respectively. The control bias for the former is derived from a potentiometer, R1, whereas that of the latter is obtained from a rotary switch, S1. Trim potentiometers, R83 and R97 respectively, are provided for claibrating these phase controls; they are located on the p-c card.

Each of the multivibrators receives a servo control voltage, "A", as described in the section "Servo for 50% Duty-Cycle" to maintain the desired phase-shift constant over the frequency range in use.

Output Multivibrator, MV 4

The purpose of this circuit, identical to that of the other multivibrators, is to provide a duty-cycle of 50% in the phase-shifted waveform applied to the demodulator gates via the Driver (Q38-Q39).

In the OUT position, all multivibrators are by-passed so that the amplified and limited reference signal is applied directly to the gates.

Second-Harmonic Operation

When it is desired to detect at the second harmonic of the reference frequency, the f/2f switch S3 is placed in the "2f" position. Thereupon, the output of MV1 is frequency-doubled by Inverter Q31 and the "OR" network (CR14 and CR24) before being applied to the phase-shifter MV2. At the same time, the control bias voltages applied to MV2, MV3, and MV4 are each reduced to exactly one-half their normal values in order to maintain the calibration of the front-panel phase dials.

When detecting at the second harmonic, the precision to which a 50% duty-cycle in the gate waveform is maintained will dictate the extent to which the fundamental of the carrier frequency is rejected. Therefore, it may be desirable to trim the Balance Control R2 (see section on "Servo for 50% Duty-Cycle") for maximum rejection of the fundamental at the specific operating frequency.

3. DISPLAY MODULE

General

The Display Module contains two separate elements of the basic 353 system: the Post Amplifier and the Regulated Power Supply. The latter provides +15 volt and -15 volt dc power to all modules which may be plugged into the Model 350S1 Rack Adapter.

Post Amplifier

The Post Amplifier is a hybrid operational amplifier that provides a gain of 10 or 1000 following the demodulator. For most applications, and particularly when the source noise level is high, the rear panel switch should be in the "1000"position. In this position the rated sensitivity and noise handling capability of the instrument are achieved. In the "10" position, the sensitivity of the instrument is decreased by 100, which means that the sensitivity setting on the B1 must be multiplied by 100 to obtain the actual instrument sensitivity (i.e. the 1μ volt setting requires 100μ volt input for full scale output). This position is used in those applications where the output signal dynamic range must be maximized. For example, the rated long term drift in the "1000" position is .1% of full scale (10mv), and in the "10" position is .001% of full scale (.1mv). The full scale output in either position is 10 volts, In the "10" position, the maximum peak-to-peak noise may not exceed the full scale sensitivity setting (x100) by more than 10 to 1.

In addition, the full scale signal at the detector input/output is 1 volt in the "10" position.

Associated with this post amplifier are two low pass RC filter networks, whose time-constants can be switched in unison by front-panel control S2. The first of these networks is connected in series with the non-inverting input of the amplifier, and can be optionally bypassed by placing switch S7 in the "6 db" position. This designation refers to the fact that the limiting slope of the amplifier high-frequency response is then 6 db per octave, rather than 12 db per octave. The lesser slope may be required for stability when the 353 is used in a closed-loop servo system. The second network is located in the feedback network of the amplifier.

In the "10" position, the effective time constant of the feedback filter section is reduced by a factor of 100, so it is effectively removed from the circuit. The 6/12 db switch should always be set to the 12 db position when the post detection gain switch is on "10". The slope thus obtained in this mode is 6 db per octave.

Large signal inputs or switching transients can accumulate considerable charges on the filter capacitors. When using the longer time constants, it will be found convenient to operate S3 momentarily to RESET to discharge these capacitors.

A d-c zero-suppress capability is provided by 10-turn potentiometer R3, which can inject an offset signal adjustable from 0 to 10 times full-scale, into the feedback network of the amplifier. The polarity of this signal is selectable by S4, which should be left in the "0" position when the feature is not in use, to avoid any residual offset. In the "10" position, the zero suppress range is ±10% of full scale.

An additional offset control on the rear panel is provided for trimming the output offset to zero.

Since the panel meter responds only to direct current, it cannot indicate the presence of noise signals exceeding the overload limit of the amplifier. Therefore, an alarm circuit and indicator lamp, identical to that in the B1 module, is provided; it is triggered by an output signal of approximately 8 volts peak.

Power Supply

This unit contains two conventional series-type regulators, for the positive and negative 15-volt supplies respectively. They are stabilized by Zener diodes CR5 and CR6 correspondingly. Potentiometers R25 and R24 (on the p-c card) are provided for factory adjustment of the regulated output voltages to within 1% of 15 volts.

Overload and short-circuit output currents are limited to approximately 500 ma by sensing resistor R5 and transistors Q4 for the positive supply, and R17 and Q9 for the negative supply.

For operation from 240 volts, see D40547 for instructions.

Panel Meter Switching

The primary function of the panel meter is to indicate the average value of the 353 output.

Panel switch S5 selects for display on the output of either of 2 channels. Output BNC connector J1, located on the front panel is in parallel with the meter, so that any customer meter or recorder connected to it will also be switched. On the other hand, connector J2, located on the rear panel, is permanently tied to the output of the post-amplifier (channel 1) in the Display Module. Switch S5 should normally be in the "1" position.

The actual d-c output voltage at J1 is to be read on the "10" scale of the meter as 10 volts full scale. The purpose of the "3" scale is to facilitate direct reading of corresponding input signals. For example, if the SENSITIVITY switch of the B1 module is set to "30UV, the "3" scale has a calibration of 30 microvolts full scale.

Another function of the panel meter is to confirm that the reference channel circuits in the C1 module are correctly processing the reference signal. This is observed by operating S8 to the RESET position, then letting it spring return to the REF position. The meter should swing towards full-scale to the right, and then slowly recover to a positive indication of half-scale.

TEST & CALIBRATION

Display Module

Initial Conditions - To apply unless specifically excepted in subsequent tests:

1) Terminate input by connecting a short between pins 8 and 11 of P1. NOTE: This termination only approximates the actual dynamic output impedance of the "C" module; however, it will suffice for detecting any gross errors in the Display module, prior to system test. Also short pins 2 and 10 of P1.

2) Terminate output with a 2.7 K ohm ±5% resistor across J2.

3) Set front panel switches as follows:

S1 - "ON"	S9 - Hi
S4 - "D"	S8 - "SIG"
S5 - "1"	S7 - "12"
S2 - 1 SEC	

SAFETY CAUTION: EXPOSED 120V AC TERMINALS: FOR ALL TESTS EXCEPT ADJUSTMENTS ON A2, THE LEFT-SIDE COVER PLATE (PART 9) MUST BE SECURED IN PLACE.

DC Supply Voltage Calibration - A2 Card

1) Load each side of ±15 volt supply at P1 terminals to approximately 150 MA.

2) Adjust R25 and R24, respectively, for positive and negative voltages of 15 ±0.15 volts.

Post Amp - Offset Adjust

1) Instrument must have been exposed to room temperature for at least one hour prior to this test.

2) Adjust R4 (rear panel) for offset not exceeding ±5mv, measured across J2.

Post Amp - Gain Check

1) Adjust mechanical zero of panel meter, with S5 temporarily in "2" position.

2) Remove jumper between pins 8 and 11 of P1, and apply a 9 mv (±0.2%) dc signal between them, with + to 8.

3) Verify that gain of post amplifier is 60 db ± 0.1 db, by measuring output across J2 with a DVM. Also, that panel meter reads 9.0 volts ±2%.

4) Repeat steps 2 and 3 for a negative 9 mv input.

5) Leave set up for next test.

Hi - Lo Switch Check (S9)

1) Place S9 in the (Lo) position.

2) Increase the dc signal of (-9 mv) from step 4 of the previous test to 900 mv.

3) Verify that gain of post amplifier is 20 db ± 0.1 db, by measuring output across J2 with a DVM. Again panel meter should read -9 volts ±2%.

4) Remove dc signal and restore short between pins 8 and 11.

Post Amp - Zero Suppress Calib.

1) Check and reset if necessary, the mechanical zero of R3 dial.

2) Set R3 dial to 1.00 and S4 to "+".

3) Select R2 to give 10 v ± 3% on DVM at J2.

Time Constant Switch Check

1) Measure with an accuracy of better than ±10% the actual time constant for each position of S2 and record. S7 to be at "12". For shorter values, follow procedure (1a) using input pins 8 and 11 of P1 and observe J2 output waveform, on a scope set on DC. For longer values, short input and use zero suppress switch as a source, and observe panel meter, using stop watch.
CAUTION: Panel markings are for single section; for two sections, voltage will reach 60% (not 63%) of final value in <u>two</u> time constants.

1a. Set db/octave filter on 12. Set time constant at 1 m sec. Apply a 40 cycle sine wave to input and adjust for a 1 volt reference level output. This represents reference point * on time constant check chart. Raise input level 6 db and increase frequency till voltage again reads 1 volt. (This should be within ±10% of 159 cycles.) Reduce input level 6 db, set time constant at 3 m sec and again adjust frequency to secure a 1 volt output. Record under the 0 db-1 volt chart column and repeat former procedure.

	0-db Pt. 1-Volt	6 db Pt.	(IDEAL)
1M SEC	*40 cycles		159
3		77	53
10		60	15.9
30			5.3
100			1.59
300 RECORD			.53
1 SEC			
3			
10			
30			
100			
300			

Panel Meter - Reference Mode Check

1) Set S8 to "REF".

2) Apply a +7.5 VDC signal, in series with a 150.0 K ±1% resistor between pin 13 (positive) and pin 2 of P1.

3) Panel meter should read 5.0 volts ±2%.

Overload Lamp Check

1) Set TC switch to 1 msec.

2) Apply a 50 hz sine wave to pin 8 & 10 of P1.

3) Increase signal amplitude slowly until overload lamp just lights. CAUTION: This test is made difficult by the slow release time of the lamp circuit.

4) Overload trip, referred to output, should be approximately 12 volts peak-to-peak.

TEST & CALIBRATION

B1 Amplifier

DC Supply Voltages - Check

1) Determine that the supply voltages, on the p-c card, labeled "15V DEC" are within 0.5 volt of this value, and that those labeled "13V REG" are within 1.0 volt of this latter value. Reference is card signal ground, pin 2 of connector P1.

Input Stage - Low Frequency Balance

1) Set SENSITIVITY switch S1 to 100 μV (i.e. 40 db net over-all gain). Set GAIN Pot R56 to approximate mechanical center.

2) Set INPUT switch S2 to "A-B". Front-panel ground switch "ON".

3) Apply a 1 volt RMS 1KHz sine wave signal to inputs A and B in parallel.

4) Observe output waveform at B & C on rear panel.

5) Adjust balance pot R23 for minimum RMS voltage at above output. It should be at least 30 db below 1 volt.

Input Stage - Balance Check

1) Repeat steps 1-4 inclusive, of previous test, except with SENSITIVITY switch S1 and 30μV setting, in order to include IC1 in the amplifier circuit.

2) Do not change R23 setting, but measure output voltage. It should be at least 20 db below 1 volt.

3) With SENSITIVITY switch S1 at 100 μV check output at 100 KHz. It should be below 1V.

Overall Gain Calibration

1) Set SENSITIVITY switch S1 to 30μV.

2) INPUT Switch S2 to "A". Front-panel ground switch "ON".

3) Apply a 1KHz sine wave signal having an amplitude of 3MV RMS to the "A" input.

4) Adjust Gain Pot R56 for an output of 1.08 RMS (± 1%).

5) Determine, for every other setting of S1, that the overall gain is within ±1% of the ratio 10.8 divided by the S1 setting. Maintain output signal at approximately 1 v RMS during these measurements.

6) Check gain with input on B.

Overlaod Lamp Check - Input Overload

1) Set SENSITIVITY switch S1 to 300 MV.

2) Set INPUT switch S2 to "A".

3) Applying a 1KHz sine wave to input A, increase its amplitude slowly until the overload lamp just lights. Note that this procedure requires extra care because of the slow release time of the lamp circuit. Trip point should be approximately 3 volts peak-to-peak at input.

Overload Lamp Check - Output Overload

1) Set SENSITIVITY switch S1 to 100 μV.

2) Repeat steps 2 and 3 of above test.

3) Trip point should be approximately 8 volts peak-to-peak at output.

Bandwidth - LF Cutoff - High Gain

NOTE: Measure with scope probe, with no cable hookup except scope.

1) Set SENSITIVITY switch S1 to 3μV.

2) Set INPUT selector to "A".

3) Applying sine wave signal to A input determine that HF 3db frequency is at least 250 KHz. Use an output signal of approximately 1 V RMS.

Noise Check

Measure noise at max. gain (80db), inputs shorted, 1 Hz Bandwidth.

f	INPUT A	INPUT B
31.5Hz	_____(-148db)	_____(-148db)
1KHz	_____(-158db)	_____(-158db)
31.5KHz	_____(-160db)	_____(-160db)

TEST & CALIBRATION

C1 Demodulator

Introduction

The purpose of these tests is to determine that the C1 module is in proper working order, and that its calibrating controls are capable of being set to the required values. A final and more precise setting of these controls must be deferred until the System Test. Therefore, a resonably accurate waveform observation on a scope will suffice where adjustment of duty cycle is specified herein.

Threshold Detector - Offset Adjustement

1) Apply a 100 mv peak-to-peak sine wave of 500 Hz to REF IN.

2) PHASE switch to OUT. f/2f switch to "f".

3) FREQ. RANGE switch to 100 Hz - 1KHz.

4) Observing square wave at GATE OUT, adjust R30 on card for 50% duty cycle.

5) Increase input signal to 20v peak-to-peak, to determine that duty cycle is still 50%.

Servo Loop - Duty Cycle Adjustment

1) Apply a 1 volt peak-to-peak sine wave of 500 Hz to REF IN.

2) FREQ. RANGE switch to 100 Hz-1KHz. f/2f switch to "f".

3) PHASE controls both to 0°

4) Observing square wave at GATE OUT, adjust BAL control (R2 on front panel) for 50% duty cycle.

Servo Loop - Duty Cycle Verification

1) With controls as above, verify 50% duty cycle for input frequencies of 100 Hz and 1 KHz, respectively.

2) Repeat step (1) above except with f/2f switch in "2f" position. Output should now be twice the input frequency.

3) For each of the other positions of the FREQ. RANGE switch, verify that a 50% ±2% (±5% at 100 KHz) duty cycle is present at GATE OUT, for both the top frequency and the bottom frequency of each range while in the f mode, and only the 1-10Hz and 100-200KHz range while in the 2f mode.

Quadrature Phase Shifter - Trim

NOTE: Externally sync scope.

1) Apply a 1 volt peak-to-peak sine wave of 500 Hz to REF IN.

2) FREQ. RANGE switch to 100 Hz-1KHz.

3) PHASE controls: quadrature to 90°, fine to 0°. f/2f switch to "f".

4) Adjust R97 for a 90° ±2° relative shift when quadrature PHASE control is switched from 90° to 180°.

Quadrature Phase Shifter - Verification

1) With controls as above, verify that a phase shift of 90° ±2° takes place between each of the following adjacent positions of the quadrature switch: 0° to 90°, 90° to 180° to 270°. Repeat this observation for each of the other positions of the FREQ. RANGE switch, using an approximate mid-band test frequency for each range.

Continuous Phase Shifter - Trim

1) Apply a 1 volt peak-to-peak sine wave of 500 Hz to REF IN

2) FREQ. RANGE switch to 100Hz - 1KHz. f/2f switch to "f".

3) Verify mechanical zero setting of fine PHASE control.

4) Adjust R83 for 180° ±5° phase shift when fine PHASE control is 180° position on front panel.

Calibration Trim

1) Apply a 1v peak-to-peak sine wave of 500 Hz to REF IN

2) FREQ. RANGE switch to 100Hz - 1KHz.

3) Observe waveform at CAL OUT and adjust R106 for 20mv peak-to-peak output ±1%.

TEST & CALIBRATION

Basic System

Introduction

1) This procedure covers the system-level testing of a basic 353 system composed of a B1 Amplifier, a C1 Demodulator, and a Display Module, in a 350S1 Rack Frame.

2) It is assumed that each of the above components has been tested to determine that it is in proper working order, and that a preliminary setting of its calibration controls has been made, to the extent indicated at the module test level.

Preliminary Adjustments & Checks

1) Signal ground terminal at rear of Rack Frame to be disconnected from the power-line ground via link.

2) Verify positions of panel switches as follows:

OUTPUT to "1"
ZERO SUPP. dial and switch to "0"
METER switch "SIG"
FILTER slope switch to "12 db"
f/2f switch to "f"
LOW LIMIT switch to 1 hz
POST DET. GAIN switch to x1000

3) Before making each of the individual tests in this procedure:

a) Inspect all switches and controls to make certain that they have not been inadvertently moved from their intended settings.

b) In particular, verify that the FREQUENCY RANGE switch setting agrees with the reference frequency being used.

c) Allow 15 seconds after turning on power, for regulators in B1 module to stabilize.

Adjust Offset

1) Allow instrument to stabilize at normal room temperature for at least 15 minutes.

2) Check mechanical zero of panel meter. This may conveniently be done by momentarily switching OUTPUT switch to "2".

3) SENSITIVITY switch to 100 mv.

4) Input selector switch to "A".

5) Short "A" input BNC connector.

6) Position of phase controls is immaterial.

7) TIME CONSTANT switch to 300m SEC.

8) Apply a 500 Hz sine-wave signal of approximately 800mV RMS amplitude to REF IN.

9) With no C1 in the system short pins 8 & 11 together. Remove any DC offset with pot R4 on D1. Now remove short and install C1. Adjust any further offset in system with pot R16.2 on the A2 card of C1 module. R3

10) If necessary, fine adjust OFFSET control on rear of display module for 0 ± 5mv offset at OUTPUT connector.

11) Check + and - positions of ZERO SUPPRESS switch for equal deflections of ±10V, ±3% on meter scale with the dial set to 1.

Phase Circuitry Check

Momentarily operate METER switch to RESET position, which should allow the pointer to gradually return to near half-scale. This test determines that the phase circuitry has properly acquired the applied reference signal. Now return the switch to "SIG" position.

Phase Shifter Balance

1) Apply a 500 Hz sine wave of 800 millivolts RMS (±1%) to both the REF IN and to the input of an attenuator. Set the latter for 20 db attenuation, and connect its properly-terminated output to the "A" signal input of the 353. Operate the f/2f switch to the 2f position.

2) Adjust BAL control (on front panel of C-1 module) for a minimum deflection of the panel meter, which should be less than 50 mv.

3) Explore various settings of PHASE controls, to determine that null is always less than 300 MV.

Phase Shifter Calibration

1) Continue set-up as above, except return f/2f switch to "f". Verify settling of phase-shifter circuits.

2) Set quadrature PHASE switch to 0°, and adjust fine PHASE control for a null on the panel meter. Lock fine PHASE control.

3) Change quadrature PHASE switch to 180 and verify settling of phase-shifter circuits.

4) Trim R97 (located on circuit card inside C1 module) for minimum deflection of panel meter.

5) Operate quadrature PHASE switch to first 90° and then 270°. Panel meter should indicate approximately -8.0 volts ±3% and +8.0 volts ±3% respectively.

6) Unlock fine PHASE control, check mechanical zero of knob, and then lock control at precisely 180° dial setting. Set quadrature PHASE switch at 90°. Verify settling of phase-shifter circuits. Adjust R83 (located on circuit card inside C-1 module) for minimum deflection of panel meter.

Phase Shifter Check

NOTE: 800 mV REF IN must be maintained throughout this test.

1) With 800 MV RMS input to REF IN and to an attenuator set 20 db, apply output of latter to the "A" input. Change frequency to 5 Hz. Verify settling of phase shifter circuits. Set quadrature PHASE control to 90°. Adjust fine PHASE control for meter null.

2) Operate quadrature PHASE switch slowly through 0°, 90°, 180°, and 270°. Observe panel meter for corresponding deflections of approximately -8.0 volts, ±3%, 0 volts, +8.0 volts ±3% and 0 volts.

NOTE: Before operating in the 5KHz and 50KHz ranges it is helpful first to remove any existing dc offset by shorting the input of B1 and using the zero suppress controls to locate a null on the readout meter. Switch through fine and course controls first to find max. (+) & (-) deflection, then null so that deflection are equalized.

3) Repeat steps (1) and (2) for frequencies of 50 Hz, 500 Hz, 5KHz, 50KHz, Be sure to verify settling after each change in frequency; also, to readjust fine PHASE control for null (with quadrature switch at 90°) for each frequency.

4) Using B input, repeat check at 500 Hz.

System Gain Check

NOTE: Use H-P 355D attenuator with 50 ohm terminations on both input and output to provide input signal. Drive attenuator with reference signal from wavetek oscillator use the following initial settings:

Input switch to A
Ground switch ON
f/2f to f
Post detection gain 1000
Reference input 300 mv RMS

1) With 500 hz input and 10 mv sensitivity, insert 10 mv RMS signal to A input. (Set phase controls for max. + deflection). Adjust gain of B1 with R56 until 353 output reads 10.0 volts (use DVM). Check for symmetrical + and - outputs for 180° phase shift.

Output Rejection Check

1) Apply a 520 Hz sine wave signal, having an amplitude of 300 millivolts RMS to both the REF IN and to the input of an attenuator. Set the latter at 40 db and connect its properly-terminated output to the "A" input. Float signal generator ground.

2) INPUT selector to "A" . Input ground switch closed SENSITIVITY switch to 3 MV. FREQUENCY RANGE switch to 100Hz-1KHz. f/2f switch to "f". Verify settling of phase-shifter circuits. Close gnd. bar at rear of 350 rack.

3) Manipulate PHASE controls to obtain a maximum positive deflection of the panel meter, which should read 10 volts ±3%.

4) Remove cable carrying 520Hz signal into "A" input, and feed into the "A" input to 50Hz sine wave from a second generator. Adjust amplitude of this signal until exactly 10 volts peak-to-peak is observed at output BNC. Float both the second generator and the scope.

5) As a result of step (4), the panel meter indication should be less than 100 MV.

Noise and Coherent Signal Check

1) Apply a 500 Hz sine wave signal of approximately 2 volts peak-to-peak to REF IN only. Set post detection gain to 1000.

2) Short the "A" input to the shell of its BNC connector; INPUT switch to "A", input ground switch "ON", SENSITIVITY to 1μv.

3) Set FREQUENCY RANGE to 100 Hz-1KHz; f/2f switch "f" TIME CONSTANT to 10 sec; fine phase 0°, verify settling of phase-shifter circuits.

4) Rotate quadrature PHASE switch slowly, and observe maximum average panel meter deflection, which should not exceed ±200 millivolts at each setting of quad. switch, reset filter, read after 1 minute.

5) Observe that peak-to-peak noise swings on meter over 1 minute time interval, do not exceed 200 millivolts. TIME CONSTANT should be a 1 SEC.

6) Repeat step (4) with sensitivity setting of 300 mv. Deflection should not exceed 3 mv. TC = 1 sec.

7) Repeat step (4) at 200 KHz at sensitivity of 10μv. Null DC with zero suppress, deflection should not exceed ±250 mv as phase switch is rotated. Set fine phase at 180° for this test.

8) Repeat (6) at 200 KHz, deflection should not exceed ±150 mv.

Drift Check

1) Record output overnight with following settings.

500 hz ref. input.
300 mv sensitivity
signal inputs open
"f"
1 sec, 12 db/octave
post detection gain = 1000

The short term (20 min) noise should not exceed 10 mv peak-to-peak. Long term drift should not exceed 10 mv.

WARRANTY

ITHACO Inc. warrants each instrument to be free of defects in material and workmanship for a period of one year after shipment to the original purchaser; batteries are specifically excluded. Liability under this warranty is limited to repairing or adjusting any instrument returned to the factory for that purpose. The warranty of this instrument is void if the instrument has been modified other than in accordance with written instructions from ITHACO, or if defect or failure is judged by ITHACO to be caused by abnormal conditions of operation, storage or transportation.

This warranty is subject to verification by ITHACO, that a defect or failure exists, and to compliance by the original purchaser with the following instructions:

1. Before returning the instrument, notify ITHACO with full details of the problem; include model number and serial number of the instrument involved.

2. After receiving the above information, ITHACO will give you shipping instructions or service instructions. After receipt of shipping instructions, ship the instrument to ITHACO. Full liability for damage during shipment is borne by the purchaser. It is recommended that instruments shipped to us be fully insured and packed surrounded by at least 2 inches of shock-absorbing material.

ITHACO reserves the right to make changes in design at any time without incurring any obligation to install same on units previously purchased.

This warranty is expressly in lieu of all other obligations or liabilities on the part of ITHACO, and ITHACO neither assumes, nor authorizes any other person to assume for it, any liability in connection with the sales of ITHACO instruments.

ITHACO INC.
735 W. Clinton Street
Ithaca, New York 14850
Telephone: 607-272-7640

REVISIONS		D 40547	
SYM.	DESCRIPTION	DATE	APPROVAL

S2C S2E S2A S2D S2B S2A1 S1 S2 S3 S4 S5 S6 S7 S8 R1 R2 R3 R4 R5 R6 R7 R8 R9 R10 R11 R12 R13 R14 R15 R16 R17 R18 R19 R20 R21 R22 R23 R24 R25 R26 R27 R28 R29 R30 R31 R32 R33 R34 R35 R36 R37 R38 R39 R40 R41 R42 R43 R44 R45 R46 R47 R48 R49 R50 R51 R52 R53 R54 R55 R56 R57 R58 R59 R60 R61 R62 R63 R64 R65 R66 R67 R68 R69 R70 R71 R72 R73 R74 R75 R76 R77 R78 R79 R80 R81 R82 R83 R84 R85 R86 R87 R88 R89 R90 R91 R92 R93 R94 R95 R96 R97 R98 R99 R100 R101 R102 R103 R104 R105 R106 R107 R108 R109 R110 R111 R112 R113 R114 R115 R116 R117 R118 R119 R120 R121 R122 R123 R124 R125 R126 R127 R128 R129 R130 R131 R132 R133 R134 R135 R136 R137 R138 R139 R140 R141 R142 R143 R144 R145 R146 R147 R148 R149 R150 R151 R152 R153 R154 R155 R156 R157 R158 R159 R160 R161 R162 R163 R164 R165 R166 R167 R168 R169 R170 R171 R172 R173 R174 R175 R176 R177 R178 R179 R180 R181 R182 R183 R184 R185 R186 R187 R188 R189 R190 R191 R192 R193 R194 R195 R196 R197 R198 R199 R200 R201 R202 R203 R204 R205 R206 R207 R208 R209 R210 R211 R212 R213 R214 R215 R216 R217 R218 R219 R220 R221 R222 R223 R224 R225 R226 R227 R228 R229 R230 R231 R232 R233 R234 R235 R236 R237 R238 R239 R240 R241 R242 R243 R244 R245 R246 R247 R248 R249 R250 R251 R252 R253 R254 R255 R256 R257 R258 R259 R260 R261 R262 R263 R264 R265 R266 R267 R268 R269 R270 R271 R272 R273 R274 R275 R276 R277 R278 R279 R280 R281 R282 R283 R284 R285 R286 R287 R288 R289 R290 R291 R292 R293 R294 R295 R296 R297 R298 R299 R300 R301 R302 R303 R304 R305 R306 R307 R308 R309 R310 R311 R312 R313 R314 R315 R316 R317 R318 R319 R320 R321 R322 R323 R324 R325 R326 R327 R328 R329 R330 R331 R332 R333 R334 R335 R336 R337 R338 R339 R340 R341 R342 R343 R344 R345 R346 R347 R348 R349 R350 R351 R352 R353 R354 R355 R356 R357 R358 R359 R360 R361 R362 R363 R364 R365 R366 R367 R368 R369 R370 R371 R372 R373 R374 R375 R376 R377 R378 R379 R380 R381 R382 R383 R384 R385 R386 R387 R388 R389 R390 R391 R392 R393 R394 R395 R396 R397 R398 R399 R400 R401 R402 R403 R404 R405 R406 R407 R408 R409 R410 R411 R412 R413 R414 R415 R416 R417 R418 R419 R420 R421 R422 R423 R424 R425 R426 R427 R428 R429 R430 R431 R432 R433 R434 R435 R436 R437 R438 R439 R440 R441 R442 R443 R444 R445 R446 R447 R448 R449 R450 R451 R452 R453 R454 R455 R456 R457 R458 R459 R460 R461 R462 R463 R464 R465 R466 R467 R468 R469 R470 R471 R472 R473 R474 R475 R476 R477 R478 R479 R480 R481 R482 R483 R484 R485 R486 R487 R488 R489 R490 R491 R492 R493 R494 R495 R496 R497 R498 R499 R500 R501 R502 R503 R504 R505 R506 R507 R508 R509 R510 R511 R512 R513 R514 R515 R516 R517 R518 R519 R520 R521 R522 R523 R524 R525 R526 R527 R528 R529 R530 R531 R532 R533 R534 R535 R536 R537 R538 R539 R540 R541 R542 R543 R544 R545 R546 R547 R548 R549 R550 R551 R552 R553 R554 R555 R556 R557 R558 R559 R560 R561 R562 R563 R564 R565 R566 R567 R568 R569 R570 R571 R572 R573 R574 R575 R576 R577 R578 R579 R580 R581 R582 R583 R584 R585 R586 R587 R588 R589 R590 R591 R592 R593 R594 R595 R596 R597 R598 R599 R600 R601 R602 R603 R604 R605 R606 R607 R608 R609 R610 R611 R612 R613 R614 R615 R616 R617 R618 R619 R620 R621 R622 R623 R624 R625 R626 R627 R628 R629 R630 R631 R632 R633 R634 R635 R636 R637 R638 R639 R640 R641 R642 R643 R644 R645 R646 R647 R648 R649 R650 R651 R652 R653 R654 R655 R656 R657 R658 R659 R660 R661 R662 R663 R664 R665 R666 R667 R668 R669 R670 R671 R672 R673 R674 R675 R676 R677 R678 R679 R680 R681 R682 R683 R684 R685 R686 R687 R688 R689 R690 R691 R692 R693 R694 R695 R696 R697 R698 R699 R700 R701 R702 R703 R704 R705 R706 R707 R708 R709 R710 R711 R712 R713 R714 R715 R716 R717 R718 R719 R720 R721 R722 R723 R724 R725 R726 R727 R728 R729 R730 R731 R732 R733 R734 R735 R736 R737 R738 R739 R740 R741 R742 R743 R744 R745 R746 R747 R748 R749 R750 R751 R752 R753 R754 R755 R756 R757 R758 R759 R760 R761 R762 R763 R764 R765 R766 R767 R768 R769 R770 R771 R772 R773 R774 R775 R776 R777 R778 R779 R780 R781 R782 R783 R784 R785 R786 R787 R788 R789 R790 R791 R792 R793 R794 R795 R796 R797 R798 R799 R800 R801 R802 R803 R804 R805 R806 R807 R808 R809 R810 R811 R812 R813 R814 R815 R816 R817 R818 R819 R820 R821 R822 R823 R824 R825 R826 R827 R828 R829 R830 R831 R832 R833 R834 R835 R836 R837 R838 R839 R840 R841 R842 R843 R844 R845 R846 R847 R848 R849 R850 R851 R852 R853 R854 R855 R856 R857 R858 R859 R860 R861 R862 R863 R864 R865 R866 R867 R868 R869 R870 R871 R872 R873 R874 R875 R876 R877 R878 R879 R880 R881 R882 R883 R884 R885 R886 R887 R888 R889 R890 R891 R892 R893 R894 R895 R896 R897 R898 R899 R900 R901 R902 R903 R904 R905 R906 R907 R908 R909 R910 R911 R912 R913 R914 R915 R916 R917 R918 R919 R920 R921 R922 R923 R924 R925 R926 R927 R928 R929 R930 R931 R932 R933 R934 R935 R936 R937 R938 R939 R940 R941 R942 R943 R944 R945 R946 R947 R948 R949 R950 R951 R952 R953 R954 R955 R956 R957 R958 R959 R960 R961 R962 R963 R964 R965 R966 R967 R968 R969 R970 R971 R972 R973 R974 R975 R976 R977 R978 R979 R980 R981 R982 R983 R984 R985 R986 R987 R988 R989 R990 R991 R992 R993 R994 R995 R996 R997 R998 R999 R1000

FOR S2 ASM SEE C30781

OVERLOAD CIRCUIT

FRONT PANEL DS2 OVERLOAD LAMP

TO S8-2 (GRD)

P1 BLUE RIBBON

TO J2 LUG (SIG GRD)

TO S5-1 (CH. 2 OUT)

TO S8-4 (REF STATUS)

TO S3-1 (C1 RESET)

TO P1-LUG

(+15V)

(-15V)

(GRD)

(GRD)

RESET

100Ω

2UF 1UF

.0015UF .0015UF

A1-A1

-IN

+IN

R4 OFFSET ADJUST 2.0K

C.W

348K

3.16K

10 (X100)

1000

S6

348Ω

29.4K

6 DB

12 DB

-15V

+15V

A2 POWER SUPPLY CARD ASM- C 30778 EL. DIAG- C30586

+15V -15V GRD GRD

AC TICT AC IN & SHLD IN

NOTE:

1. JUMPERS SHOWN ON TB1 ARE FOR 120V OPERATION. FOR 240V OPERATION REMOVE JUMPERS BETWEEN 1&2, & 3&4, THEN ADD A JUMPER BETWEEN 2&3.
2. UNLESS OTHERWISE STATED: * INDICATES A1 CARD GRD; X INDICATES 1/8W, 1% RESISTOR
3. FOR REFERENCE SEE: ASM - D40351; CABLE DIAG - D40344; RUN. LIST - A10[illegible]56

E1 INSULATED STANDOFF (MOUNTED ON S2 ASM)

13.3K 750Ω 1/2W 750Ω 1/2W 6.8V

R7 7.5K *

R5 REF TRIM 833Ω, ±1% C.W

J2 OUTPUT

J3 RECORDER OUTPUT

CTR LUG

FROM P1-2 (GRD)

A1 POST AMP CARD ASM- D40539 EL. DIAG- D40538

S2A1 P.C. CARD STACKED BETWEEN S2B & S2C

C1 .033UF C2 .33UF 35V C3 3.3UF 35V C6 68UF 15V C4 68UF 15V C5 330UF 6V

M1 100-0-100 uA

SIG REF RESET

S8 FROM P1-3 (C1 RESET)

FROM P1-13 (REF STATUS)

R6 100K S7-1

S4 R2 SELECT

R3 ZERO SUPPRESS 10 TURN 500Ω C.W

FROM D52

S5

J1 OUTPUT (FRONT PANEL)

FROM P1-12 (CHANNEL 2 OUTPUT)

T1 TRANSFORMER RED BLK WHT WHT BLK WHT BLK

TB1 SEE NOTE 1

E2 MOUNTED ON TB1

R1 100K

DS1 POWER PILOT

FRONT PANEL MOUNT

E3 GRN

F1 0.5A SLO-BLO

S1 POWER

NO C NC

115V 60 HZ

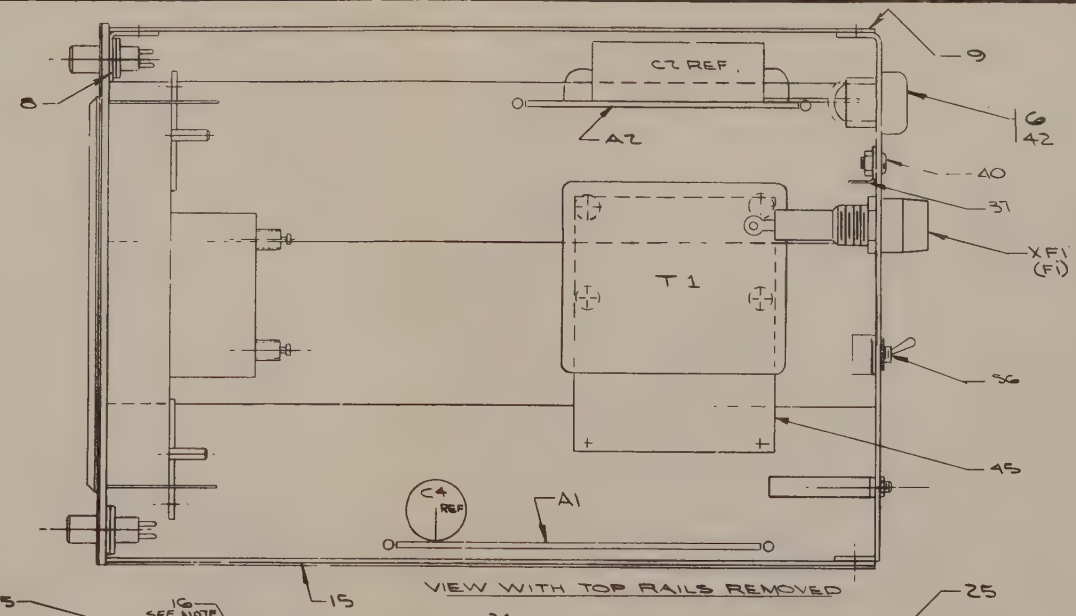
FRONT PANEL MOUNTED

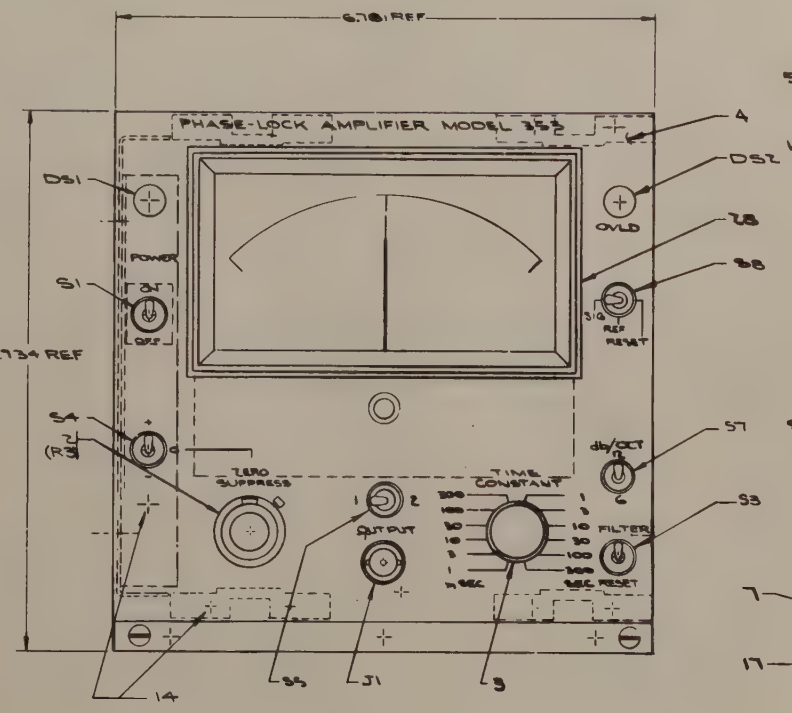
A1

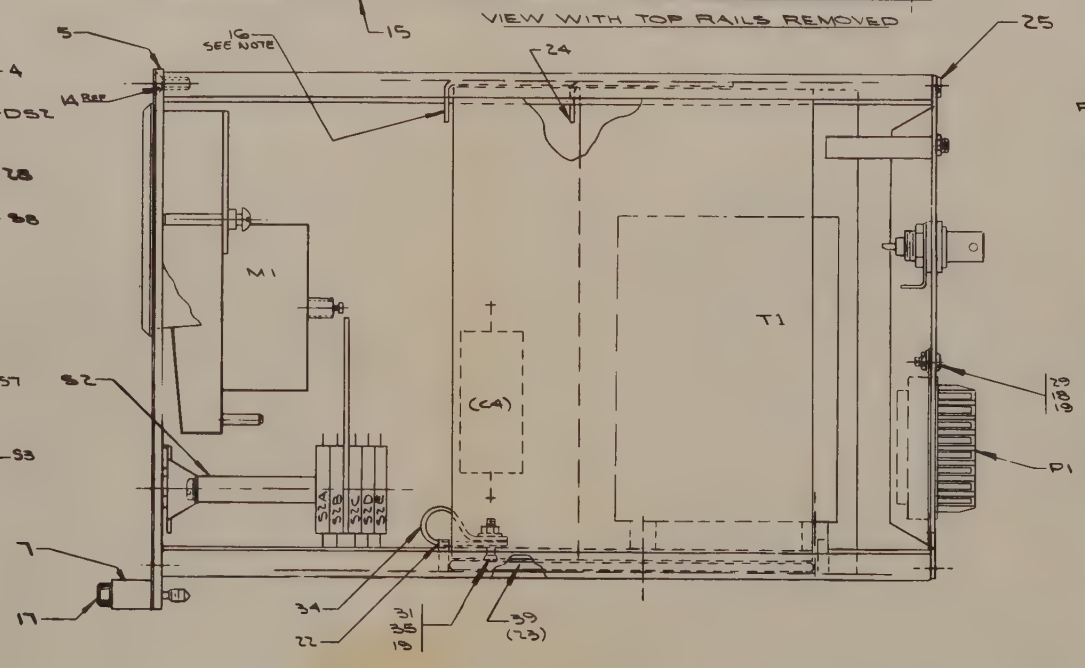
ELEM. DIAG. DISPLAY MODULE MODEL 353 D1 FMF 5018-34		ITHACO, INC. ITHACA, N. Y.
DRAWN BY [illegible] 11 Nov 69		
APPROVAL: DFTG [illegible] ENG [illegible]		D 40547
ISSUE DATE [illegible]		CONT. ON SH E IN SH NO. 1

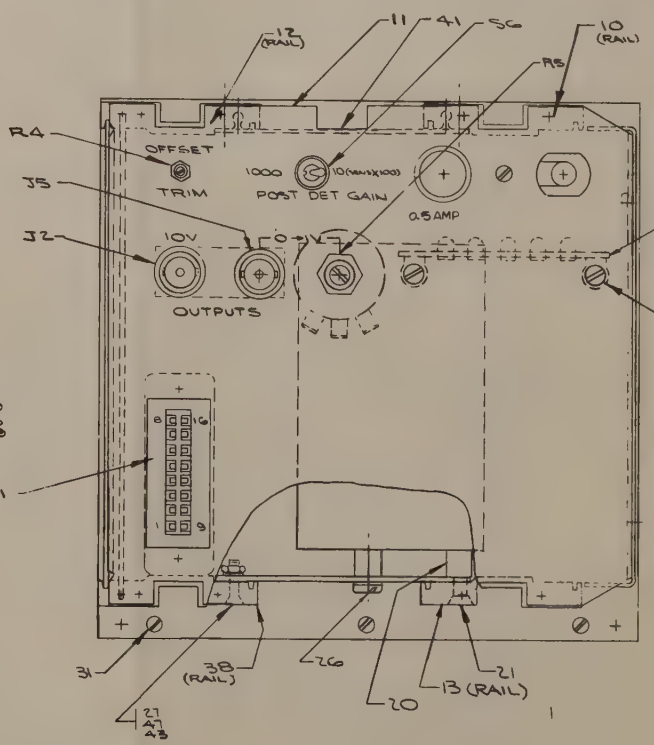
UNLESS OTHERWISE SPECIFIED DIMENSION: ARE IN INCHES TOLERANCES ON FRACTIONS ± DECIMALS ± ANGLES ±

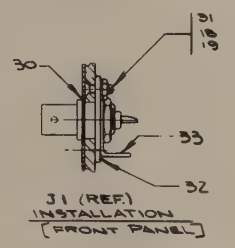
REVISIONS		D 40351 CONT. ON SH. — SH. NO.	
SYM.	DESCRIPTION	DATE	APPROVAL
A	ADDED BRACKET, NEW REAR PANEL (NEW DUST CHUTE & MAN CHANGES). INW 4-15-68	4/1/68	
B	PT 12 WAS PT 10 ADDED PT A1. INW 6-7-68	6/7/68	
C	MOVED T1 ¾ AT ½ INCH TOWARD FRONT PANEL. VIEW PLAN VIEW INW 7-2-68 TITLE WAS "POST AMP/PWR SUPPLY"	7/2/68	
D	MOVED 58 (DELETED 56 & 57) 59 WAS BANANA JACKS, GRID) MOVED 35 ADDED PT 5 JS INW 10-17-68	10/17/68	
E	ADDED PT 28 INW 12-11-68	12/11/68	
F	ADDED PTS 44, 45, MOVED A1, T1, ADDED S1 INSTALLATION VIEW INW 2-6-1969	2/6/1969	
G	DELETED 33 & A3 MOVED A1 CHGD 58 MARKING ADDED PT 44 AND S1 INSTALLATION VIEW INW 3-31-69 ADDED A2 & 46	3/31/69	
H	MOVED S1, A1, PT 34, PT 11, PT 31, PT 35, PT 19, PT 39 (PTS) BACK 1 INCH - MOVED PT 41 FROM FRONT TO REAR PANEL INW 7-11-69	7/11/69	
J	RELABELED 38. INW 4-14-69 ADDED 39	4/14/69	
K	GLEMDING WAS C30353 ADDED RUNNING LIST NOTE & CHANGED BILL	8/1/69	

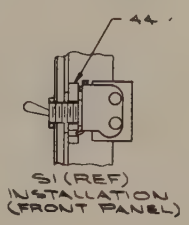


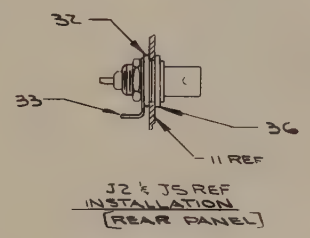












(1) ASM FOR ELEM DIAG SEE D40547
FOR CABLING DIAG SEE D40344
FOR BASIC SYSTEM FUNCTIONAL BLOCK DIAG SEE D40444.
ASSEMBLE ITEM 2 AND ADJUST TO READ 0-10 CLIP 1" OFF PT16, BREAK EDGES
FOR RUNNING LIST SEE A1055G

SEE SEPARATE PARTS LIST

A1

ASM, D1
DISPLAY MODULE
FMF MOD 353 (5016-98)

ITHACO, INC.
ITHACA, N. Y.

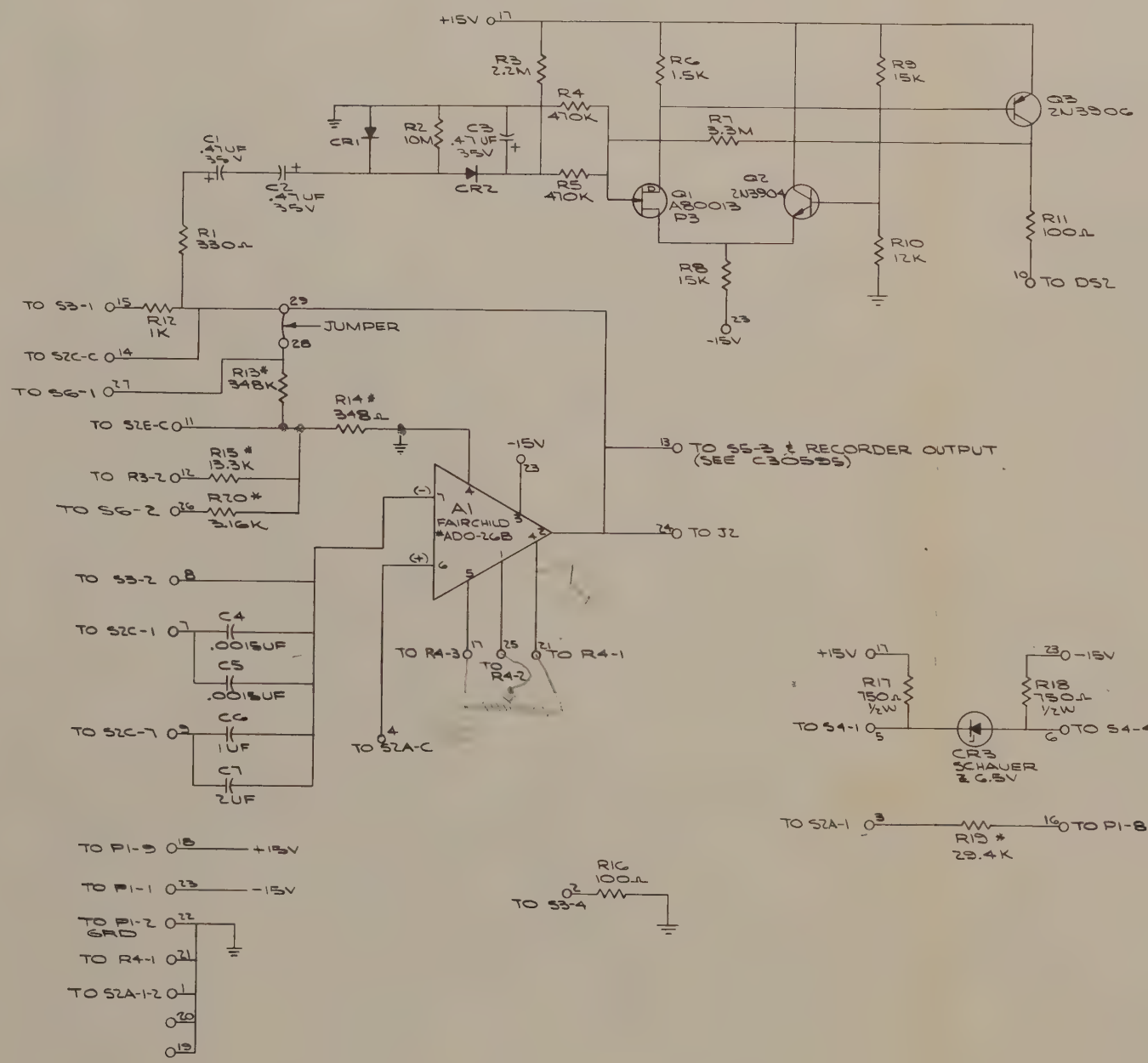
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON FRACTIONS ± DECIMALS ± ANGLES ±

DRAWN BY [illegible] Feb 26, 1968
APPROVAL: DFTG. [illegible] ENG. [illegible]
ISSUE DATE March 15, 1968

D 40351

CONT. ON SH. — SH. NO. 1

REVISIONS		D 40538 CONT ON SH F SH NO 1	
SYM.	DESCRIPTION	DATE	APPROVAL
A	C1 C2 .47UF 35V.	4/6/68	RJS



NOTE:
1. UNLESS OTHERWISE SPECIFIED:
   ALL RESISTORS ARE ¼W, 5%
   ALL DIODES ARE IN4148
2. * INDICATES ⅛W, 1%, METAL FILM RESISTORS
3. 1 THRU 15 ARE FRONT PANEL CONNECTIONS.
   16 THRU 27 ARE REAR PANEL CONNECTIONS.

A1

ELEM DIAG
A1 CARD
POST AMP
EMF MOD. 353D1 (18-34)

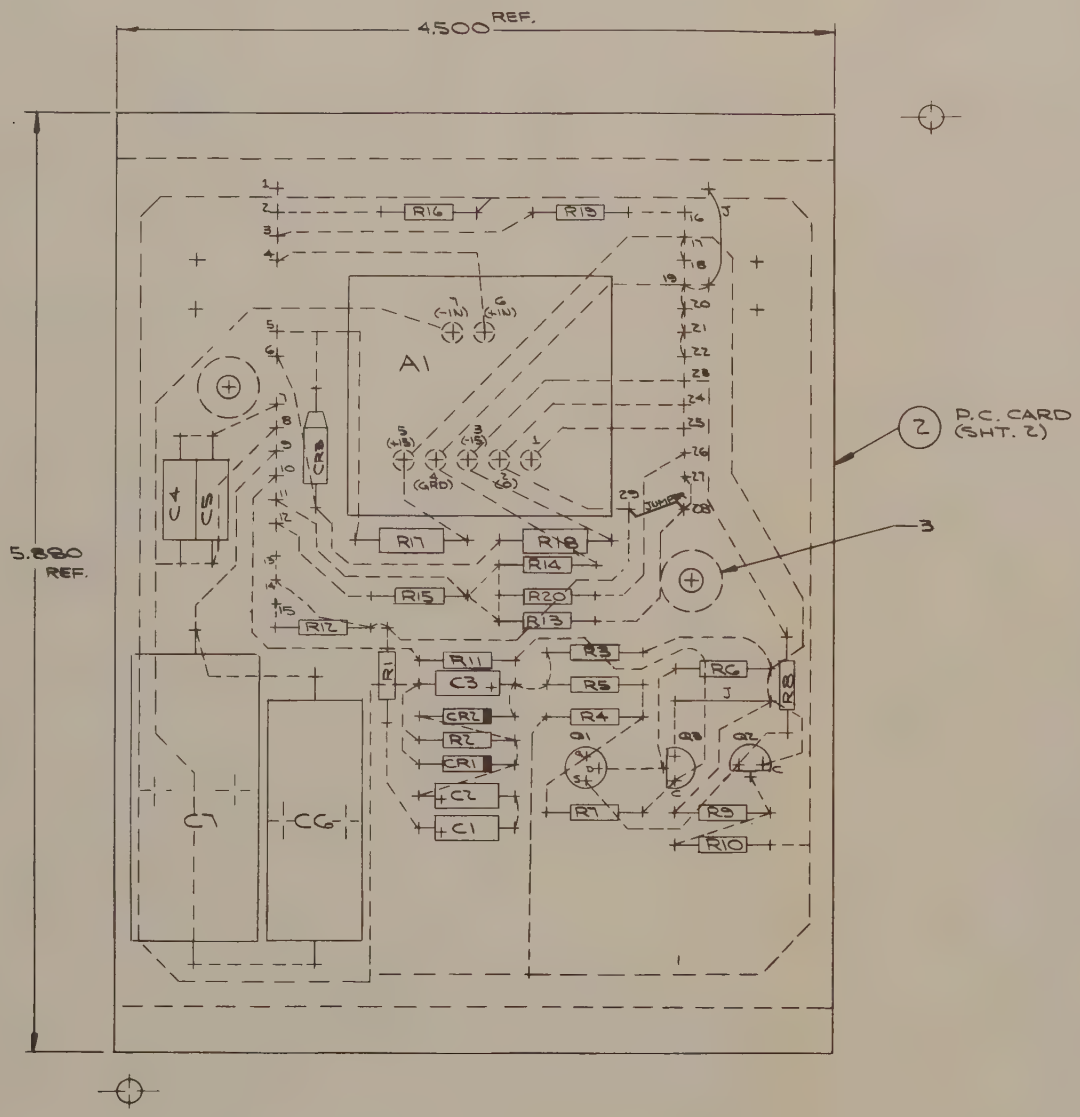
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON FRACTIONS ± DECIMALS ± ANGLES ±

DRAWN BY W. Thurston APR 1 1969
APPROVAL: DFTG. [signature] ENG. RJF
ISSUE DATE August 16, 1969

ITHACO, INC.
ITHACA, N. Y.

D 40538
CONT. ON SH F SH NO 1

REVISIONS		D 40539 CONT ON SH 2 SH NO 1	
SYM.	DESCRIPTION	DATE	APPROVAL
A	MOVED C6 & C7 DOWN, MOVED R-3, DIAD 7B & 23, FROM LEFT TO RIGHT SIDE OF BOARD. DWN J-23-69	6/16/69	



(1) ASSEMBLY
FOR ELEM DIAG SEE D40538

NOTES
1. "J" INDICATES JUMPER, 3 PLACES
2. C6 & C7 TO BE TIED DOWN

SEE SEPARATE PARTS LIST

A1

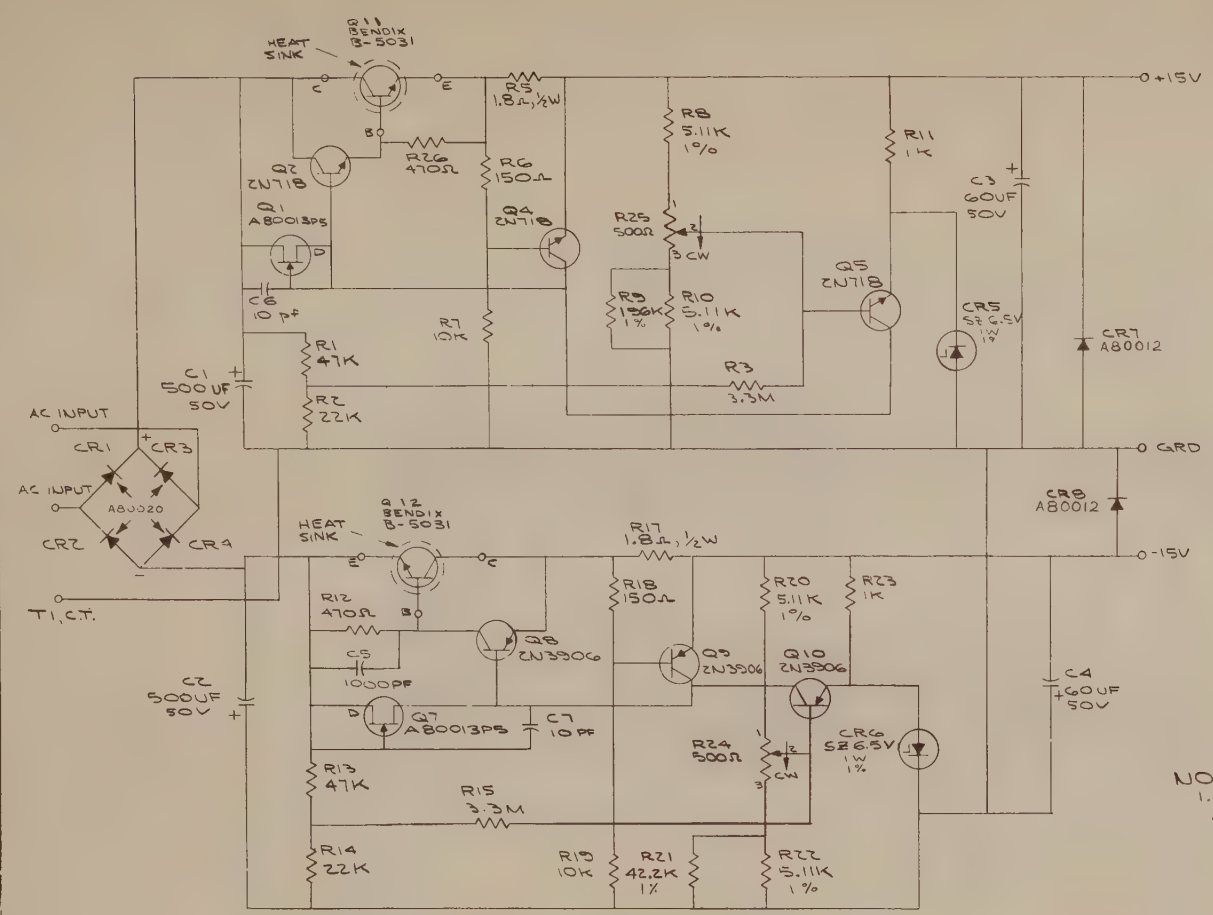
ASM, CARD
POST AMP (A1)
FMF 353D1 (18-34)

ITHACO, INC.
ITHACA, N. Y.

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON
FRACTIONS ± DECIMALS ± ANGLES ±

DRAWN BY J. Thurston Apr 1, 1969
APPROVAL: DFTG. ENG.
ISSUE DATE April 14, 1969

D 40539
CONT ON SH. 2 SH. NO. 1



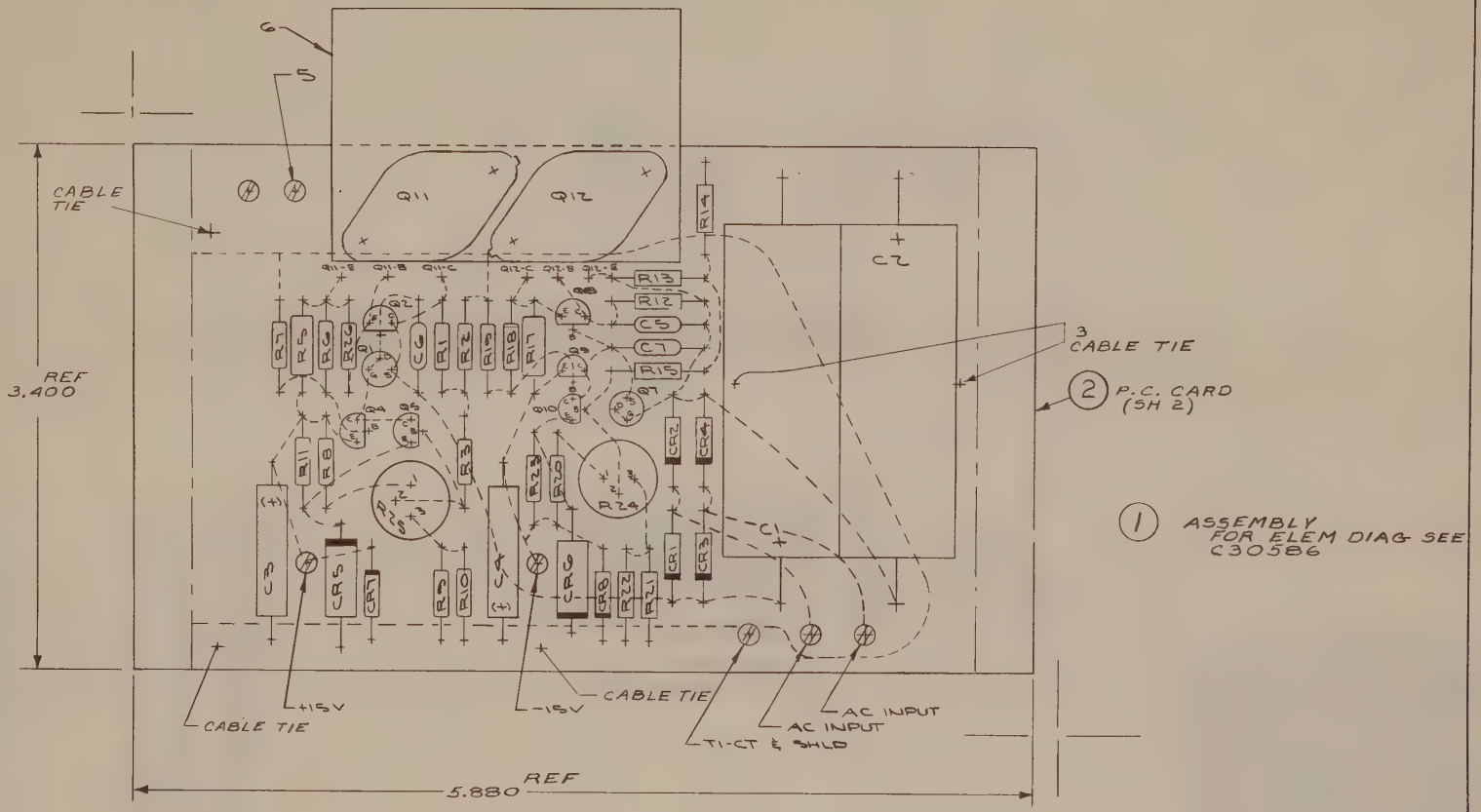
NOTES:
1. UNLESS OTHERWISE SPECIFIED ALL RESISTORS ARE ¼W, 5%

REVISIONS		C 30586 CONT ON SH. — SH. NO. 1	
SYM.	DESCRIPTION	DATE	APPROVAL
A	ADDED R24, 25 26 ECT. R21 WAS 4.7K, R22 WAS 1K, R9 WAS 68.1K, DRW A-117-68	6/6/69	DWS
B	Q11 & Q12 WERE MOUNTED ON REAR PANEL 12-27-68	" "	" "
C	R5 WAS 10Ω ½W -R6 WAS 1K - R17 WAS 10Ω ½W - R18 WAS 1K -- WGT 4-18-69	4-18-69	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS DECIMALS ANGLES ± ± ±	ELEM DIAG POWER SUPPLY (A7) FMF MODEL 353-D1	ITHACO, INC. ITHACA, N. Y.
	DRAWN BY Thomas Stewart Feb. 13, 1968	
	APPROVAL: DFTG DWS ENG TECM	C 30586
	ISSUE DATE March 15, 1968	CONT. ON SH F SH. NO. 1

A1

REVISIONS		C 30778 CONT. ON SH. 2 SH. NO. 1	
SYM.	DESCRIPTION	DATE	APPROVAL
A	MOVED CABLE-TIE HOLE		
B	ADDED PT G. MOVED Q11 & 12 TO N.S.DR., DMW - 4-21-69	4/21/69	



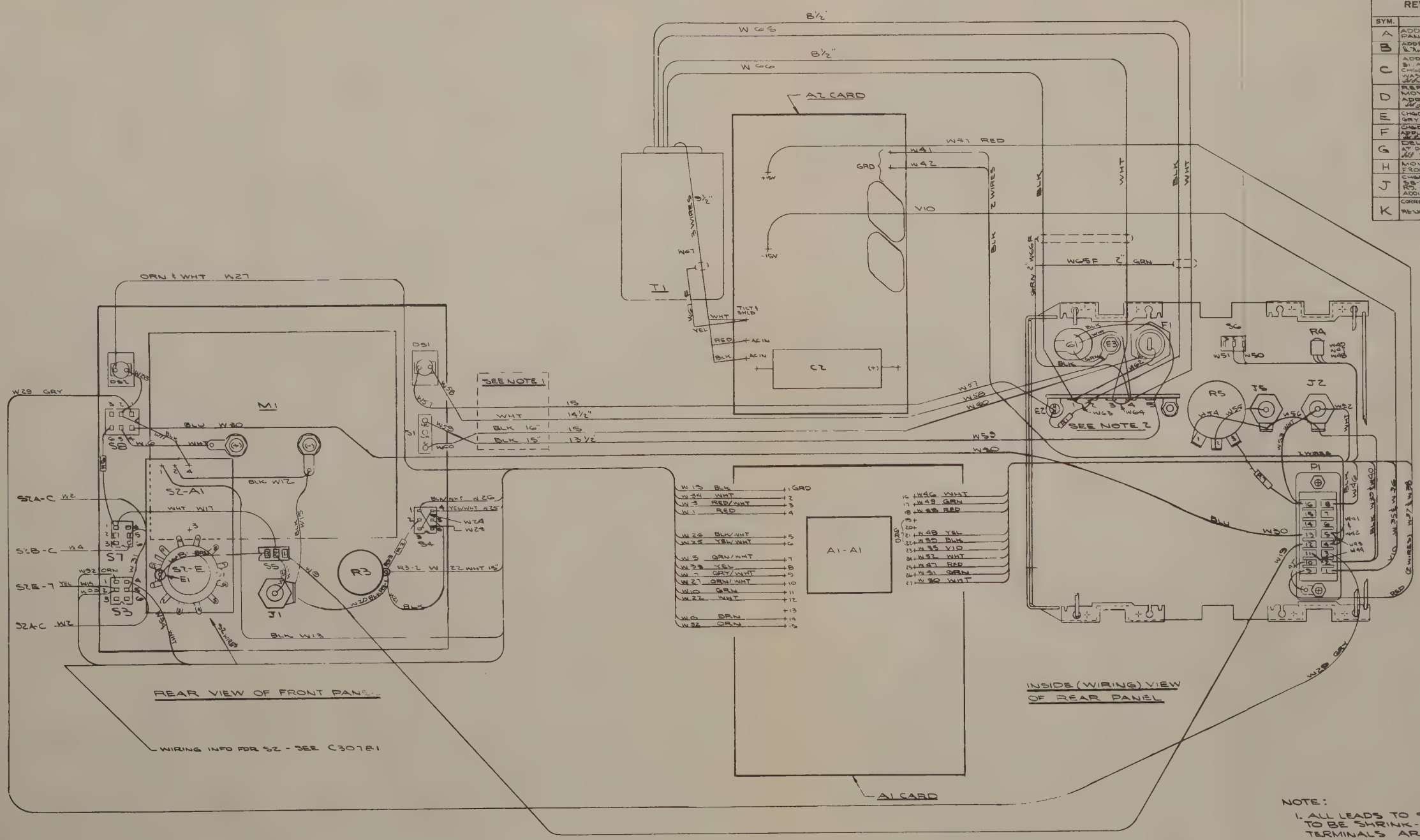
SEE SEPARATE LIST

A1

ASM, CARD POWER SUPPLY (A2) FMF MOD 353-D1 18-34	ITHACO, INC. ITHACA, N. Y.
DRAWN BY [illegible] 1-23-69	
APPROVAL: DFTG. ENG.	C 30778
ISSUE DATE	CONT. ON SH. 2 SH. NO 1

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS ± DECIMALS ± ANGLES ±

REVISIONS		D 40344 CONT ON SH — SH NO
SYM.	DESCRIPTION	DATE	APPROVAL
A	ADDED J4 & CHANGED REAR PANEL ARRANGMENT. DWG 4-15 68		
B	ADDED WIRE FROM P1-17 TO A1-B6 & DWG NO. CHGD 2-5-68		
C	ADDED C1 CHGD WIRING OF S4 & S1. ADDED WIRE COLOR CODES. CHGD DELINEATION A1A1-TB1 WAS POST AMP/PWR SUPPLY	11-1-68	
D	REPLACED S6 WITH S8. MOVED J3 DELETED J4. ADDED R3, J3,	1/20/69	RZF
E	CHGD C2 ORIENTATION. T1-2 WAS GRY	11/11/69	DWJ
F	CHGD A2 CARD. CHGD S WIRING G8 & G9 ADDED TO A2 CHGD A1 CARD		
G	DELETED J3, J4 & A3 CHGD WIRING AT DS1, J1, S5, S5, & S6. ADDED R5	JU569	
H	MOVED R1 & STANDOFF FROM FRONT TO REAR PANEL	3-17-69	
J	CHGD GRD WIRING AT DS1, S5, J1 AND CARD ON S1. DELETED R3. GENERAL WIRING CHANGES & ADDITION OF WIRE NO3. DWG 4-16 69	4/23/69	RZF
K	CORRECTED WIRING TO TB1 REVD WIRES DTD JUNE 3, 1969	9/9/69	RZF



NOTE:

1. ALL LEADS TO S1 & DS1 TO BE SHRINK-SLEEVED SO THAT TERMINALS ARE COVERED.
2. FOR ALTERNATE 240V HOOK-UP:
   REMOVE JUMPERS: FROM TB1-1 TO TB1-2
   AND TB1-3 TO TB1-4
   ADD JUMPER FROM TB1-2 TO TB1-3.

A1

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS ± DECIMALS ± ANGLES ±	CABLING DIAG DISPLAY MODULE FMF MODEL 353-D1	ITHACO, INC. ITHACA, N. Y.
	DRAWN BY [illegible] Feb 27, 1968	
	APPROVAL: DFTG. DWJ ENG. DWJ	
	ISSUE DATE [illegible] 15, 1968	D 40344
		CONT ON SH — SH NO. 1

REVISIONS		D 40401	
SYM.	DESCRIPTION	DATE	APPROVAL
—	ADDED W RE NO'S & ENGR'S.	3/11/66	[illegible]
J	CHANGED W20, DELETED W30 & W31. ADDED W34 & W35. CHANGED W25 W26 W27 W32 W33 & W36 AS SHOWN.	[illegible]	[illegible]

S1

DS1

BLK W2 3.75Ø

BLU W1 3.75Ø

J4

S5

S4

W3

W4 2.5 WHT/BLK

B3 B2 BC B1 AC C1 A3 C2 C3 A1 AE C1 A2

S2 A

2 (WHT)

W10 2 (WHT) 5.5"

J2 J1

W16F

W16 13.5"

WHT/BLK

GRN

WHT/BLU W5

WHT/GRN

INSIDE VIEW FRONT PANEL

ORN

#16

GRY

WHT/BLU

S1A REF

S1B REF

22 23

TO S1A-C

TO S1B-B

TWISTED PAIR 5 3/4" FINISHED LENGTH

WRAP THIS WIRE AROUND T-PAIR 2 WIRES TO PADS 11.

IC1 REF

C15

WHT/BLU

11 12 16

C7 REF

R26 REF

IC2 REF

R4

IC4

R1

C8 REF

C30 REF (H)

C35 REF (H)

C9 REF

C13 REF

L3

L4

L5

C31 REF

C32 REF

C33 REF

C34 REF

13 1/2"

WHT/GRN

PRINTED CIRCUIT CARD ASM
D40358G1
RUNNING LIST - A10345

GRD LUG IN FRONT OF FRAME RAIL

TWIST

J3

W17 (WHT/V10) 1.5" -13V REG

W18 (BLK) 1.5" 5V6 GRD

W19 (WHT/RED) 1.5" +13V REG

26 27 25

W20 WHT/GRN

W24 WHT/BLU

W22 BLK

J5

W23

W21

JUMPER

J4

W26 ORN 1.75"

30 31

J6

W28

W25

GRD

W27 WHT/YEL 2.5"

P1

32 33 34

INSIDE VIEW REAR PANEL

A1

WIRING DIAG
AMPLIFIER TYPE B1
MODEL 353
FMF 5016-45

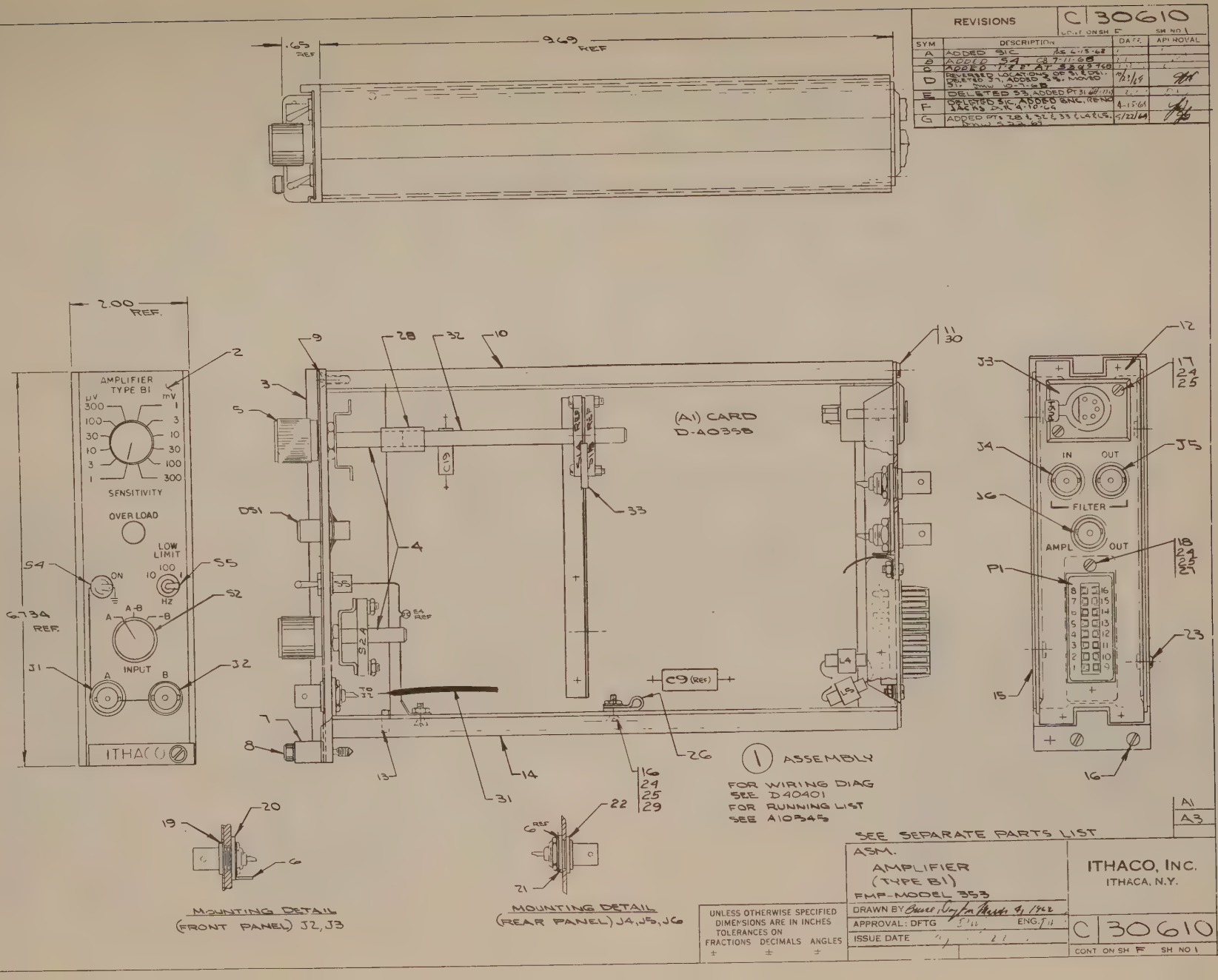
ITHACO, INC.
ITHACA, N. Y.

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON FRACTIONS DECIMALS ANGLES
± ± °

DRAWN BY [illegible]
APPROVAL DFTG [illegible] ENG [illegible]
ISSUE DATE [illegible]

D 40401

SHT NO


REVISIONS
C 30610
CONT ON SH F
SH NO 1
SYM
DESCRIPTION
DATE
APPROVAL
A ADDED SIC
B ADDED S4
C ADDED T2 AT
D REVISED LOCATIONS OF S1 (DP)
E DELETED S3, ADDED PT 31
F DELETED S1C, ADDED BNC, REND
G ADDED PTS 28 & 32 & 33 & CHG'D
.65 REF
9.69 REF
2.00 REF.
AMPLIFIER
TYPE BI
SENSITIVITY
OVER LOAD
LOW LIMIT
ON
HZ
A-B
INPUT
ITHACO
6.734 REF.
(A1) CARD
D-40358
C9 (REF)
ASSEMBLY
FOR WIRING DIAG
SEE D40401
FOR RUNNING LIST
SEE A10345
IN
OUT
FILTER
AMPL OUT
PUSH
MOUNTING DETAIL
(FRONT PANEL) J2, J3
MOUNTING DETAIL
(REAR PANEL) J4, J5, J6
SEE SEPARATE PARTS LIST
A1
A3
ASM.
AMPLIFIER
(TYPE B1)
FMF-MODEL 353
DRAWN BY
APPROVAL: DFTG
ISSUE DATE
ENG.
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
FRACTIONS DECIMALS ANGLES
ITHACO, INC.
ITHACA, N.Y.
C 30610
CONT ON SH F SH NO 1

REVISIONS	D 40398 CONT. ON SH E SH NO 1		
SYM.	DESCRIPTION	DATE	APPROVAL
A	DELETED R30 & R33 ADD R29 WIRES, SPARE 31 & 32, C18 WAS .22 UF 20V, ADDED R28 & R37, R34 WAS 51K, R35 WAS 2.7K, DELETED NOTE 9, Q13 WAS 2N3906, R40 WAS 1.5K, F 5004-49-1	1/.	TFCM
B	REARRANGED LEFT SIDE OF DIAG WITHOUT CIRCUIT CHANGE C1 3-6-68	8/1	TFCM
C	MOVED R80 REVERSED POLARITY ON S1B & S2A, ADDED FLOATING PAD & GND WAS TO PAD 33, REMOVED LEAD BTWEEN J6 & ADDED E7 E8 E9 C9 3-20-68	4/16	RZF
D	REWIRED FILTER LEADS TO S1, MOVED R41 THRU R46 FROM S1A TO S1B, DELETED S3 & S4, ADDED C19 THRU C21 & S5 Dnw 11-1-68	11-21	RZF
E	REWIRED J4. Dnw 11-9-68	11-16	RZF
F	DELETED S3 Dnw 1-13-69 ADDED C39, R15, REVERSED C16	1-17	RZF
G	R80 WAS 1.00K, C39 WAS .01UF per ECR 69	2-11	RZF
H	REMOVED IC3 & RELATED CIRCUITRY. Dnw 3-3-69	3-1-69	RZF
J	DELETED S4C, R11, C27, C28, C29 & C30 CHGD WIRING AT S2A-A, S1A-A, B, & S1A-C. J1 WAS FRONT PANEL, P1-1 WAS P1-A. per ECR 8, 1969 Dnw 4-1-69	4/1/69	RZF
K	DELETED PADS 28 & 29, J4 & J5 WAS P3, Dnw 5-15-69	6/9/69	RZF
L	C29, C12, C33 & C34 WERE .1UF, ADDED L4 & L5. Dnw 9-30-69	6/30/69	RZF
M	C7, C8 WERE 400V 6-11-69	6/11-69	Dnw
N	R80 WAS 1.21K R46 WAS 100K per ECR 6-21-69	6-27-69	Dnw

MOUNTED ON REAR PANEL

FILTER

SHIELD

IN

OUT

SHIELD

J4

JUMPER

J5

+13V REG

L1 10UH

CR1 IN4148

R1 1K

C1 2.2UF 20V

CR2 IN4148

R2 10M

E7

E8

R80 SELECT

R41* 61.9K

R15 1MEG

-13V REG

+13V REG

R42 1.5K

C16 100PF

R40* 619Ω

C15 50PF

IC1 A10SMP2

TO S1B-5

-13V REG

C17 C18 5PF 5PF

C19 100UF 10V

CR3 A80003

R3 1K

R4* 316Ω

R5* 316Ω

R6 1K

C31 .1UF

Q5 A10082 P1

Q2 A10082 P1

R14 100M

C3 150PF

C4 50PF

R8 100M

C5 0.01UF

R9* 1.96K

Q3 2N3906

Q4 2N3906

C2 0.01UF

R13* 1.96K

R12* 2.37K

R11* 1.71K

C8 .01UF 200V

Q1 A10082 P2

Q6 A10082 P2

CR3 A80003

JUMPER

CR4 A80003

R16 220Ω

-13V REG

R18 330M

PAD 6

C35 10UF 20V

C36 10UF 20V

PAD 33

10 10HZ

S5

(NC) 100HZ

PAD 10

1HZ

PAD 11

C37 1UF 35V

C38 1UF 35V

C30 100UF 10V

C6 100UF 10V

Q8 2N3904

Q7 2N3904

C32 .47UF 35V

R19* 348Ω

R21 11.0K*

R20 5.91K*

R22 287Ω

R24* 2.15K

R25 330M

R23 200Ω CW BALANCE POT

-13V REG

CR6 A80003

-13V REG

C7 0.01UF 200V

E5

JUMPER

E6

PAD 16

PAD 5

R26 220Ω

S1A

S1B

1UV

3UV

10UV

30UV

100UV

300UV

1MV

3MV

10MV

30MV

100MV

300MV

R43* 1.96K

R44* 681Ω

R45* 196Ω

R46* 97.6K .1%

TO PAD11 (C15)

R47 6.81K*

R48 2.37K*

R49 681Ω*

R50 237Ω*

R51 82.5Ω*

R53 28.7Ω*

R54 8.25Ω*

R55 2.87Ω*

R52 110Ω*

PAD 20

PAD 19

SHIELD

S2A-A

S2A-C

J1 INPUT

FRONT PANEL MOUNTED

S4

MOUNTED ON FRONT PANEL

J2 'B' INPUT

MOUNTED ON FRONT PANEL

L2 10UH

CR10 A80012P1

C9 15UF 20V

R29 470K

R28* 6.19K

C11 100 PF

R27 150Ω

Q10 2N3904

R31 2.7K

Q9 2N3904

C33 15UF 20V

C10 40UF 30V

R32 6.8M

+15V RAW

CARD TO TO P1-9

L4 2.2MH

PAD 33

TO P1-1

L5 2.2MH

PAD 32

MOUNTED FROM CARD TO CONNECTOR

L3 10 UH

CR11 A80012P1

C12 15UF 20V

R34 470K

R37* 6.19K

C14 100 PF

R38 150Ω

Q12 2N3904

R35 2.7K

Q11 2N3906

C34 15 UF 20V

C13 40UF 30V

R36 6.8M

-15V RAW

+15V DEC

-15V DEC

-13V REG

REAR PANEL MOUNTED

REMOTE PREAMP

J3 CANNON "XLR" CONNECTOR

1 REMOTE IN

2 -13V REG

3 SIG GRD

4 +13V REG

5 SHIELD

PAD 26

PAD 27

PAD 25

R56 5K

GAIN POT

R57 31.6K

R59 1.00K*

R60 1.00K*

R58 1.5K

C20 220 PF

IC2 A10SMP3

R61 220Ω

-15V DEC

C21 5 PF

R79 220Ω

PAD 30

J6 OUTPUT TEST

REAR PANEL

PREAMP SIG GRD P1-2

REAR PANEL

P1-6 OUTPUT

CR7 IN4148

R68 15K

Q13 2N3904

R69 3.3K

R75 3.3M

Q14 2N3906

Q15 A10CC11P6

R76 100Ω

PAD 1

PAD 3

R77 8.2K

R78 22K

+15V DEC

DS1 MOUNTED ON FRONT PANEL

R70 2.2M

X' (INPUT CIRCUIT)

C25 2.2UF 20V

R71 1K

CR8 IN4148

R73 470K

R74 470K

C26 1.0UF 35V

R72 10M

CR9 IN4148

NOTES:

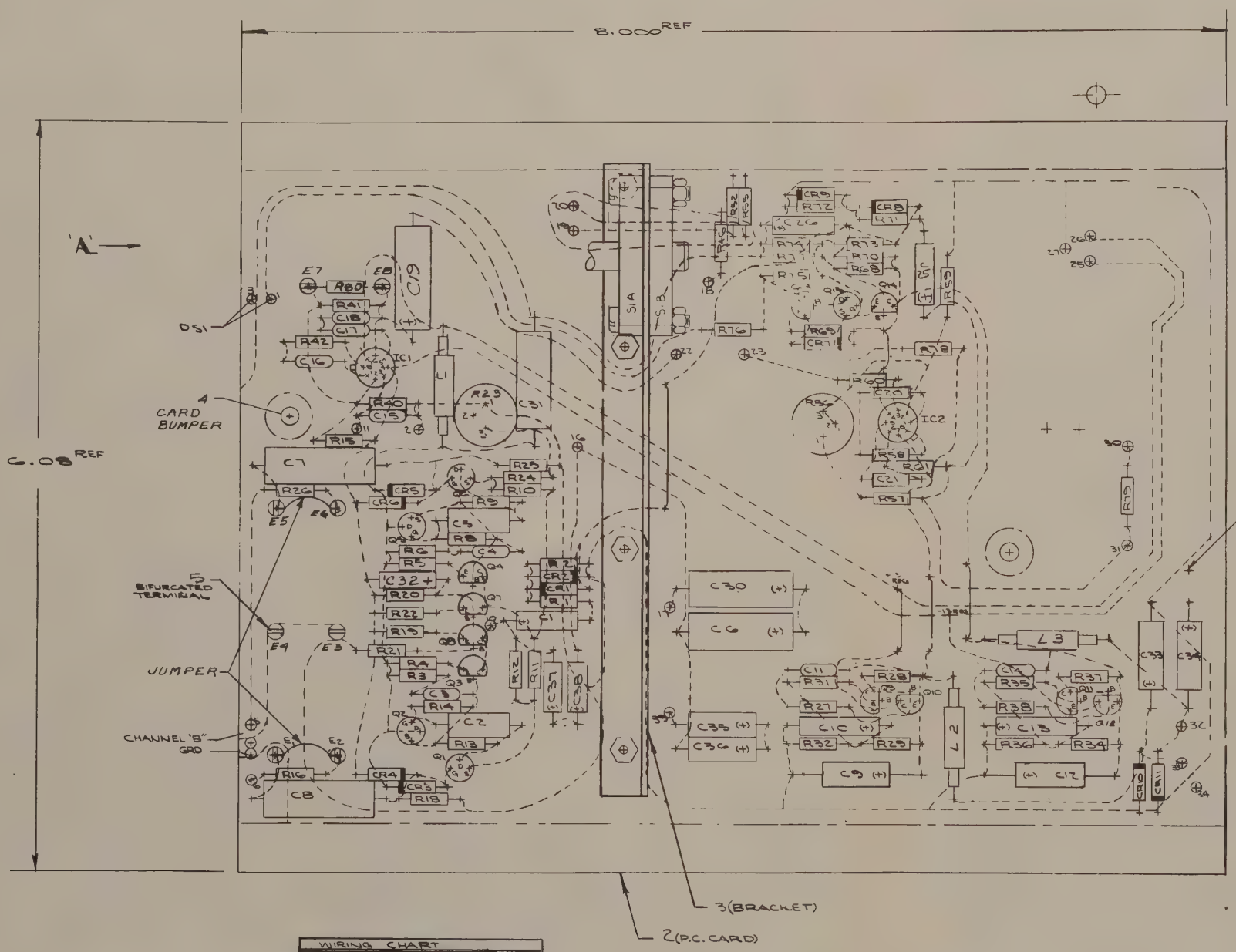
1. EXCEPT AS INDICATED RESISTORS ARE 1/4W, 5%, CARBON.
2. * INDICATES 1/8W 1% RESISTORS.
3. CAPACITORS RATED IN PF'S ARE SPRAGUE 5GA'S.
4. E1-E8 ARE BIFURCATED TERMINALS FOR FACTORY AND/OR CUSTOMER USE.
5. GROUND PLANE AT P.C. CARD EDGES MUST NOT CONTACT MODULE FRAME.
6. J1 & J2 BNC SHIELDS INSULATED FROM MODULE FRAME.
7. ⊗ INDICATES NUMBERED PAD ON CARD USED TO WIRE TO EXTERNAL COMPONENTS.

A1

ELEM DIAG AMPLIFIER (B1) FMF 5016-49 (MODEL 353)		ITHACO, INC. ITHACA, N. Y.
DRAWN BY C Smith 3-5-68		
APPROVAL: DFTG.	ENG. TRM	D 40398
ISSUE DATE		CONT. ON SH. F SH. NO. 1

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS DECIMALS ANGLES ± ± ±

REVISIONS		D 40358	
		CONT ON SH 2	SH NO 1
SYM.	DESCRIPTION	DATE	APPROVAL
A	ADDED SIC DIODE TO PAD 6 (S7-...) MOVED PADS 9 & 11 TO LEAD ANGLE CODE		
B	ADDED C30 & C31 (+) & C32, C33 & C34 (+) DELETED R137 ADDED PAD 24, WIRING CHART ADDED PAD 24 & PAD 8 TO J4 PAD 8 WAS BE A-M1 & PAD 8 WAS SLEEVE AT C5 PAD 8 WAS SLEEVE AT C4 PAD 3 WAS AT C7 WIRE AT C6 PAD 3 WAS AT C5 WIRE AT TUNNEL DIO C3 TO C6		
C	MOVED R80 TO REVERSED POLARITY ON C19, ENLARGED L1, L2 & L3, C37 & C38 ON S1A; DELETED LEAD DETAIL ON R80, ADDED LEAD DETAIL ON R80, ADDED E7 & E8	2-11-69	DWL
D	MOVED ALARM CIRCUIT FROM R137 - R34 WERE ON SIC SAME PCB. REVISED ACCORDINGLY. ADDED C36, C37 & C38. DELETED R37.	12/3/68	
E	CHANGED WIRE LIST FOR PADS 15, 16 & 21. DWG 11-5-68	11/1/68	DWL
F	MOVED C37, C38, R46, R74, R51, R55; DELETED 3 JUMPERS NEAR R61, ROTATED S1A 180° ADDED COLOR CODE TO WIRING CHART. ADDED C39 & REVISED C19		RLF
G	DELETED R61 THRU R67, C27 & C28, C24 TO S1A PAD 20 - MOVED PAD 21 - DWG 3-1-69	3-5-69	
H	DELETED 150Ω, 0.68 R17, C29, C31, C28, C25 & 200 Ω, 2K, 2 W POT, SIC, MOVED PADS 1, 2, 3, 11, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 30, 31, 32. DWG 3-10-69 DEL SIC	9 10 69	
J	DELETED PADS 28, 29 & 19. MOVED PAD 11. ADDED TO HAPER. DWG 5-22-69	5/24/69	



WIRING CHART			
PAD NO	TO	COLOR	LENGTH
11	S1B-5	WHT/BLU	3 1/2"
NOTE: 11 & 16 LIE SIDE BY SIDE ALONG BRACKET WITH THEIR LEADS UNCUT			
16	S1A-1	WHT/BRN	2"
18	S1B-9	BRN	2"
19	S1A-5	GRY	1 3/4"
20	S1A-12	ORN	2"
22	S1B-1	GRN	2 1/4"
23	S1B-C	BLU	2"
2	J4-J5 LUG	BLK	

NOTE
1. TWISTED PAIR; FINISHED LENGTH - 5 3/4" Lg
WHT/BLU - TEFLON COATED #24 AWG STRANDED WIRE
WHT/GRN - TEFLON COATED #24 AWG STRANDED WIRE.

(1) ASSEMBLY
FOR PL. DIAG. SEE D40398
FOR WIRING DIAG. SEE D40401

A1

ASM. CARD A1
AMPLIFIER TYPE B1
MODEL 353
FMF 5016-49

DRAWN BY	D Hawley Mar 14, 1968
APPROVAL: DFTG.	DWL ENG. DWL
ISSUE DATE	August 22, 1968

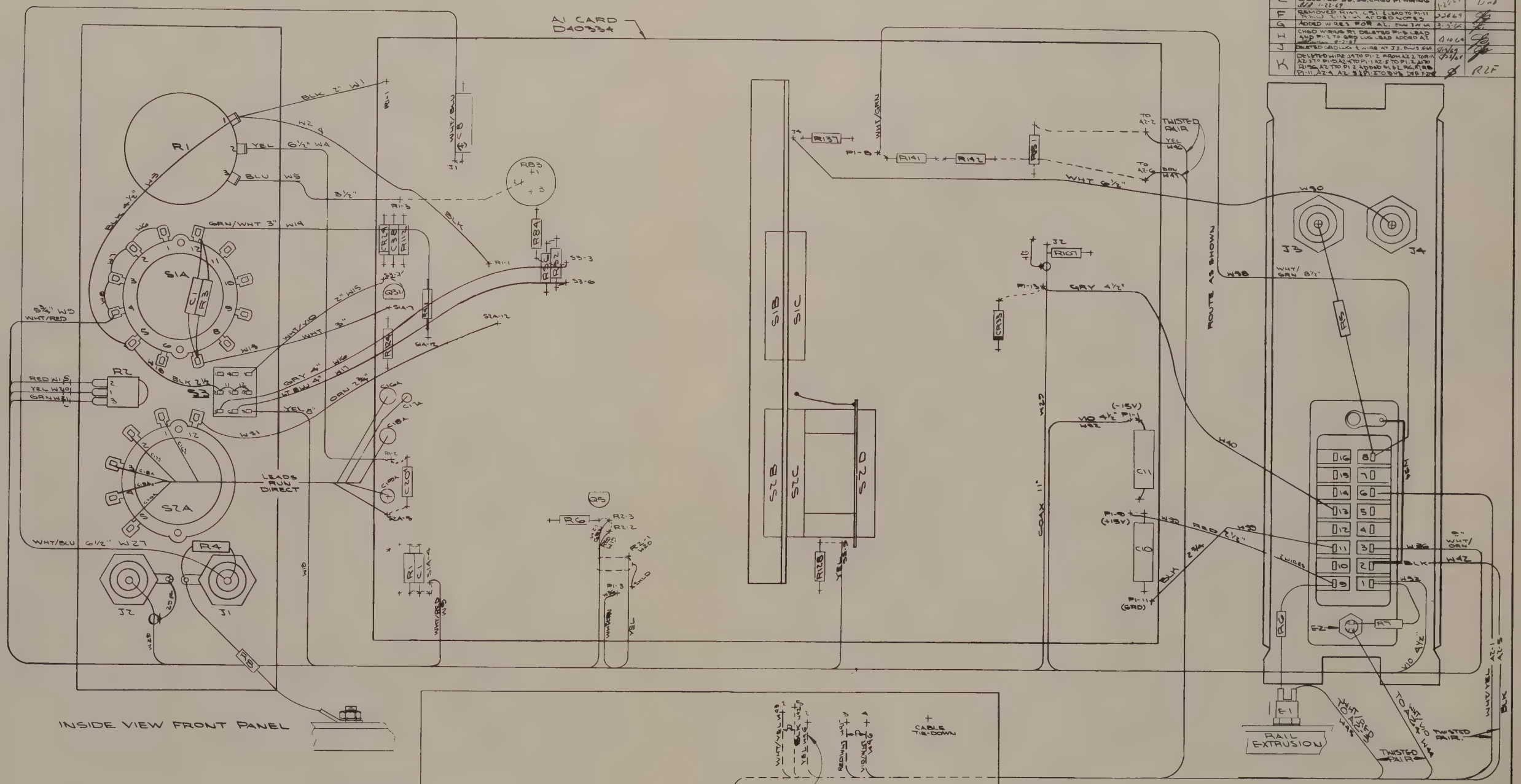
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS ± DECIMALS ± ANGLES ±

ITHACO, Inc.
ITHACA, N. Y.

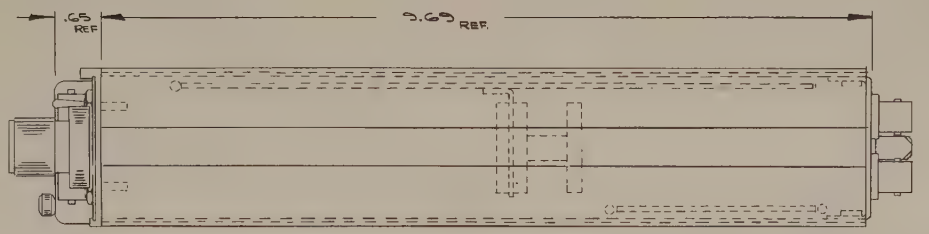
D 40358

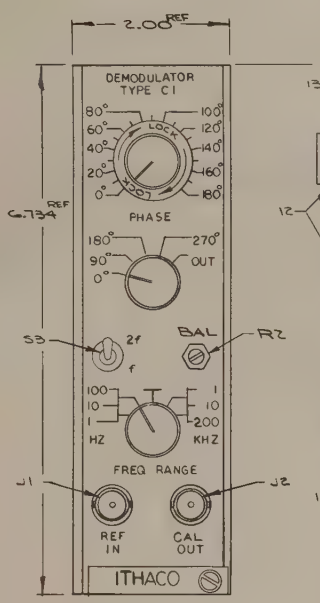
CONT. ON SH. 2 SH. NO. 1

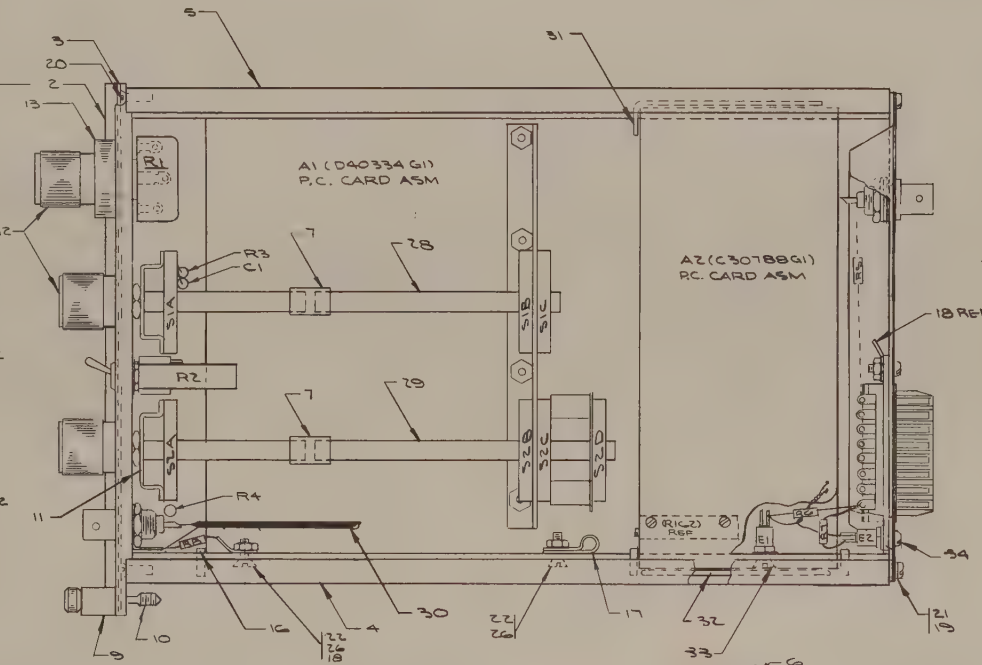
REVISIONS		D 40356 CONT ON SH — SH NO 1	
SYM.	DESCRIPTION	DATE	APPROVAL
A	REVISED & REDRAWN	1-18-66	L W J
B	CHG'L CHANGES	1-15-68	L W J
C	ADDED COLOR CODES & WIRE LENGTHS	7-10-68	L W J
D	DELETED S4 CHGD WIRING TO J1-33, J3 ADDED R84	7/11/68	
E	MOVED R1 TO FRONT PANEL DELETED S5, S6, CHGD P1 WIRING	11-22-69	L W J
F	REMOVED R141, C41, & R40 TO P1-11 CHG'D L-13-41 ADDED W132	12-26-69	
G	ADDED W132 FOR A1, DWG 14 M	3-2-70	
H	CHGD WIRING TO DELETED P1-6 LEAD AND P1-7 TO GRD W/G LEAD ADDED A1	D 40469	
J	DELETED GROUND & WIRE AT J3, DWG 5 M	2/26/73	
K	DELETED WIRE 14 TO P1-2 FROM A2-2 TO P1 A2-37 P1-13 A2-4 TO P1-11 A2-5 TO P1 & ADD 14 & 82 RG178 P1-11 A2-4 A2-5 P1-5 TO GND W/P EACH	7/7/75	RLF

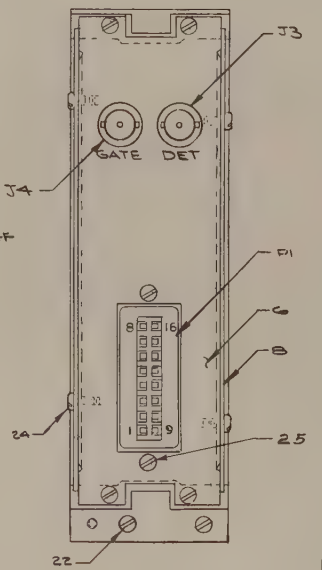


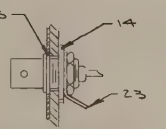
REVISIONS		C 30600 CONT. ON SH. — SH. NO. 1	
SYM.	DESCRIPTION	DATE	APPROVAL
A	DELETED R9, ADDED J4, MOVED J3 DMW 4-22-68	4/22/68	DWJ
B	ADDED R31 C1, S1 FP MARKING "100" WAS 100 William 5-15-68	5/1/68	DWJ
C	DELETED S4, MOVED R2, J3, & J4 William 8/12/68	8/21/68	
D	DELETED S5, S6, & MOVED R2 CHGD S1, S2, S3, ADDED P1 & 28P130 William 12-20-68	1-23-69	
E	ADDED A2 CARD & MTG. HARDWARE DMW 3-5-69	3-5-69	
F	ADDED R4 & R5, DELETED PT 18 ADDED RLA10544 Wil 6-8-69	6/6/69	
G	ADDED HEAT SEAL CARD, DELETED RESET DMW 9/18/69	9/4/69	
H	ADDED E1, E2, RC & ER (E8 DELETED SOLDER LUGS FROM J3 & J4 ADDED SOLDER LUG TO P1 DCR5-2769	5/21/69	

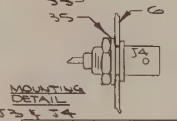












(1) ASSEMBLY

FOR WIRING DIAGRAM SEE D40356

FOR RUNNING LIST SEE RLA10544

SEE SEPARATE PARTS LIST

A1

ASM DEMODULATOR C1 MODEL 353		ITHACO, INC. ITHACA, N.Y.
FMF 5016-50		
DRAWN BY D Mosley February 27, 1968		
APPROVAL: DFTG. DWJ	ENG. DWJ	C 30600
ISSUE DATE March 6, 1968		CONT. ON SH. — SH. NO. 1

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON FRACTIONS ± DECIMALS ± ANGLES ±

REVISIONS		D 40330 CONT. ON SH 2	SH NO 1
SYM.	DESCRIPTION	DATE	APPROVAL
M	FROM: PANEL R24 WAS 100K, R24 WAS 6.8K, R27 WAS 6.8K, ZK WAS 5.1K, ZK WAS 5.1K (2)	6/19/69	RH
N	DELETED R156, ADDED R155 & R157 ON PANEL (SHT. 2-2-69)	6/19/69	RF
P	R104 WAS 31.6K DSR 6-27-69	6-27-69	DW

NOTES:
EXCEPT AS SHOWN:
1. RESISTORS ARE 1/4W, 5% RCOT'S. DIODES ARE IN4148. CAPACITORS IN pf's ARE SPRAGUE 5GA'S. CAPACITORS (TANTALUM) ARE SPRAGUE 150D'S
2. * INDICATES 1/8W, 1%, ELECTRA MFGCO'S ** INDICATES MATCHED COMPONENTS PER A80073

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON FRACTIONS ± DECIMALS ± ANGLES ±

ELEM DIAG
DEMODULATOR(E1)
MODEL 353
FMF 5014-71

DRAWN BY R. Hawley May 15, 1969
APPROVAL: DFTG. [signature] ENG. [signature]
ISSUE DATE May 29, 1969

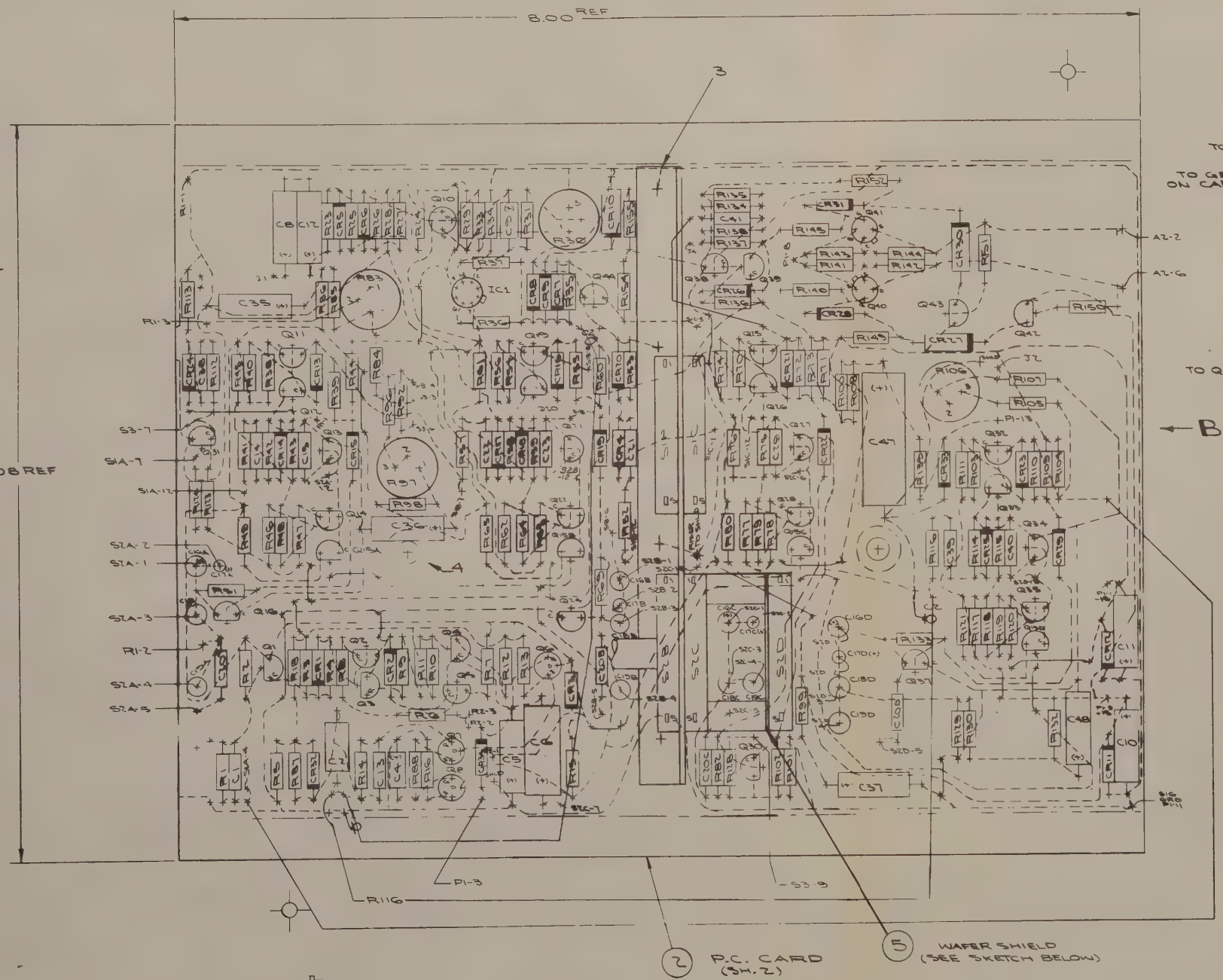
ITHACA, INC.
ITHACA, N.Y.

D 40330

CONT. ON SH. 2 SH. NO. 1

A1

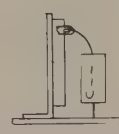
REVISIONS		D 40334 CONT ON SH. 2 SH NO. 1	
SYM.	DESCRIPTION	DATE	APPROVAL
J	ADDED P1-Z. NOTE 3 DWG S-6-68 DELETED P1-1 CALLOUT	5/28/68	
K	P1-11 WAS P1-Z DELETED 2 SHLD CALLOUT L RITE DWG E-28-69	4-21-69	
L	CHANGED SHD AT CARD FRONT DWG C-9-69	6-19-69	



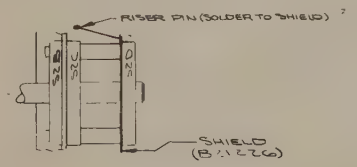
NOTE:
1. SWITCH WAFERS - BEND TABS TO NEAR SIDE IN VIEW SHOWN.
2. FOR WIRES FROM CARD TO WAFERS SEE R.L. A10576

(2) P.C. CARD (SH. 2)

(5) WAFER SHIELD (SEE SKETCH BELOW)



TYPICAL INSTALLATION OF CAPACITORS TO SWITCH WAFERS



(1) ASM FOR ELEM DIAG SEE D40330 SH 1

SEE SEPARATE PARTS LIST

A1

ASM, CARD (A1)
DEMODULATOR
TYPE C1 MODEL 353
FMF 5016-50

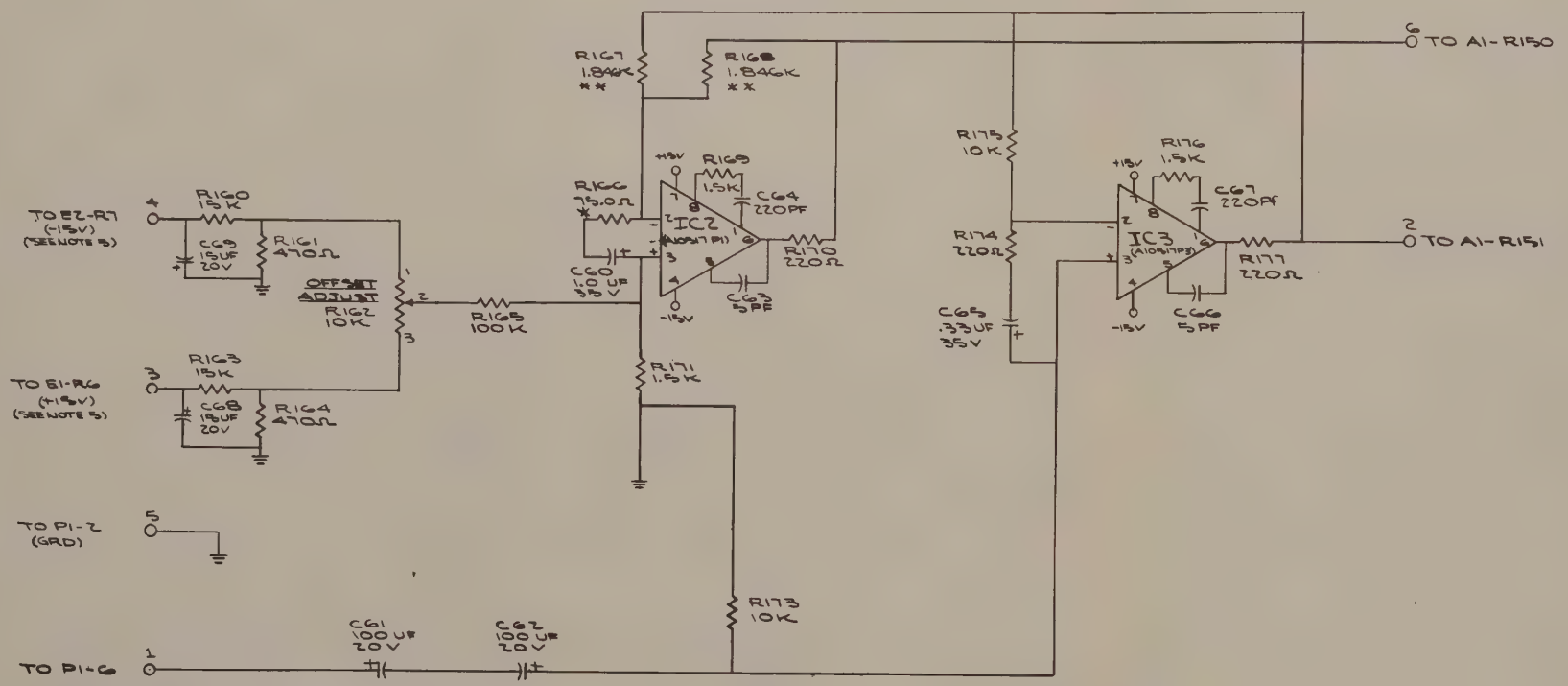
ITHACA, INC.
ITHACA N.Y.

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON FRACTIONS ± DECIMALS ± ANGLES ±

DRAWN BY D. WOOLLEY MAR 16, 1965
APPROVAL · DFTG [illegible] ENG
ISSUE DATE May 28, 1965

D 40334
CONT. ON SH. 2 SH NO 1

REVISIONS		D 140330 CONT. ON SH. — SH. NO. 2	
SYM.	DESCRIPTION	DATE	APPROVAL
A	ADDED TERM NOS 1 NOTE 4	1/1/69	[illegible]
B	R167 & R168 WERE 2.16K. DWG 3-10-69	4/1/69	[illegible]
C	R167 & R168 WERE 1.800K. R175 WAS 5K	5/14/69	RJF
D	ADDED C65 & C66. DWG 5-27-69 OBJETED PAD 1. PAD 3 WENT TO PI-3, PAD 4 WENT TO PI-4. REM E171	5/27/69	RJF



NOTES

1. EXCEPT AS NOTED:
   RESISTORS ARE 1/4W, 5%, CARBON.
   CAPACITORS RATED IN PF'S ARE SPRAGUE 5GA'S
2. * INDICATES 1/8W, 1% RESISTORS
3. ** INDICATES 1/8W RESISTORS MATCHED TO 0.1%.
4. NO'S ADJACENT TO OUTPUT TERM'S ARE REPRESENTATIVE OF MARKED TERM'S ON CARD.
5. +15V & -15V HAVE 100Ω BLOCKING RESISTORS AT REAR CONNECTOR, IN LINE TO THIS CARD ONLY.

A1

ELEM DIAG - A2 CARD
DEMODULATOR (C1)
MODEL 353
FMF

ITHACO, INC.
ITHACA, N. Y.

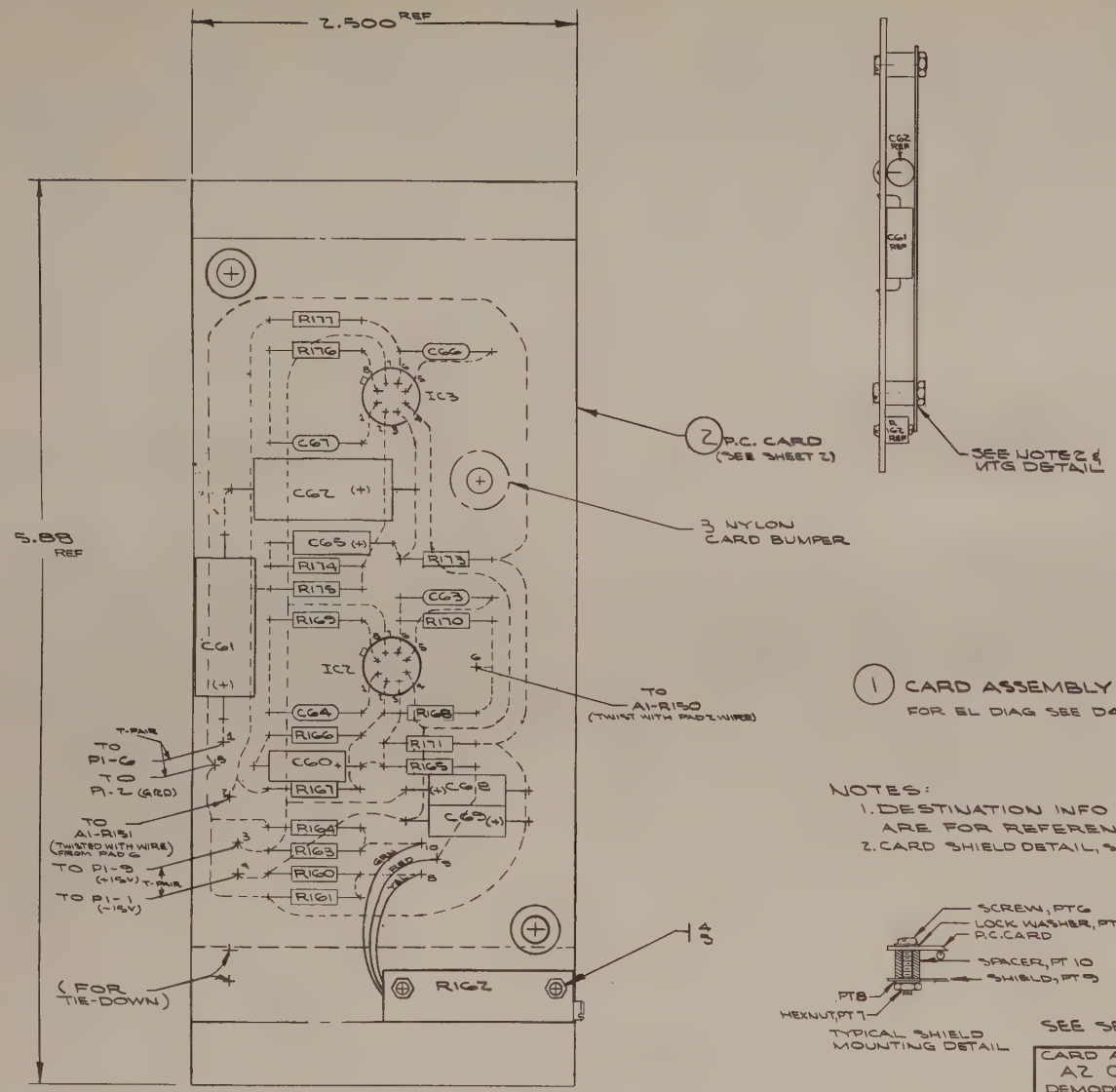
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON FRACTIONS ± DECIMALS ± ANGLES ±

DRAWN BY [illegible] MARCH 4, 1969
APPROVAL: DFTG. [illegible] ENG. [illegible]
ISSUE DATE March 7, 1969

D 140330

CONT. ON SH. — SH. NO. 2

REVISIONS		C 30788 CONT. ON SH. 2 SH. NO. 1	
SYM.	DESCRIPTION	DATE	APPROVAL
A	SHIFTED PCBOARD PATTERN UP.50 DU CARD CHGD PADS AT IC1 & IC3 NUMBERED ALL BIT WIRING PADS Ltr Issued April 9, 1969	4-7-69	
B	RIG2 WAS A IRC POT. DELETED P11 & PAD 7. ADDED C68 & C69 PTS 6-10 & SHIELD NOTE. BMW 5-20-69	5/6/69	



(1) CARD ASSEMBLY
FOR EL DIAG SEE D40330 SH2.

NOTES:
1. DESTINATION INFO FROM NUMBERED PADS ARE FOR REFERENCE ONLY.
2. CARD SHIELD DETAIL, SEE B21443 P1

TYPICAL SHIELD MOUNTING DETAIL

SEE SEPARATE PARTS LIST

A1

CARD ASM
A2 CARD
DEMODULATOR - C1
MODEL 353
FMF 18355

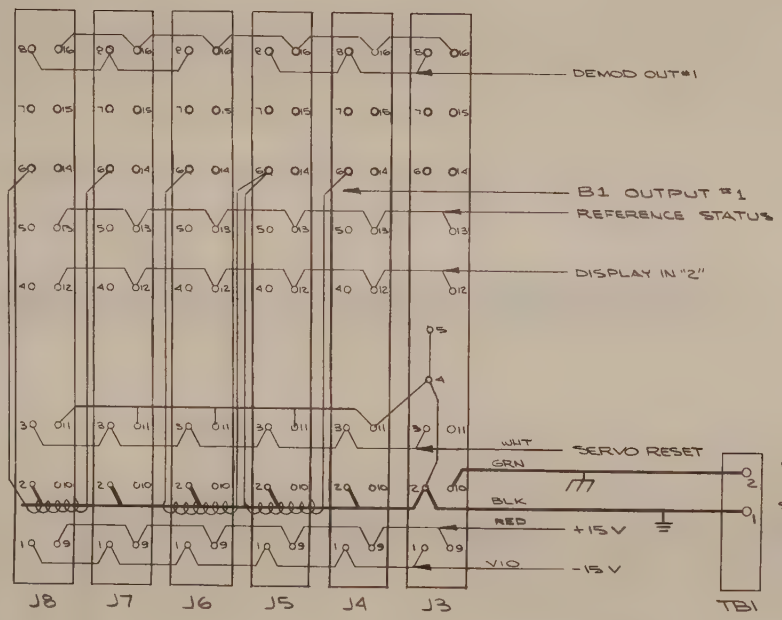
ITHACO, INC.
ITHACA, N. Y.

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON FRACTIONS ± DECIMALS ± ANGLES ±

DRAWN BY [illegible] Mar 4, 1969
APPROVAL: DFTG. 3-10-69 ENG.
ISSUE DATE March 14, 1969

C 30788
CONT. ON SH. 2 SH. NO. 1

REVISIONS		C 30650 CONT ON SH F SH NO. 1	
SYM.	DESCRIPTION	DATE	APPROVAL
A	J3-10 WAS CONN TO J4-10, DEMOD OUT GRD 1 WAS RED & WHT. J4,J5,J6 & J7,J8-10 WAS DBL. LINE. ADDED DEMOD OUT, GRD #2. SERVO OUT 'A' WAS REF STATUS. 7-17-68 CHS	7/17/68	DWJ
B	DELETED SIG GRD RUN CKS 10-68	11-25-68	DWJ
C	DELETED LEADS TO J3 THRU J8 PINS 16,15,14, & J4 THRU J8 PIN 16 & J5 THRU J8 PIN 11. DWJ 1-17-69	2-24-69	DWJ
D	J3-11, J4-11, J5-11 WERE DEMOD OUT --WENT 7-17-69	7-18-69	RZF
E	CONNECTED PIN 8 ON J4, J7 & J8. DELETED PIN 7 ON ALL. BROKE PIN 6 AT J7 & J4. DELETED PIN 5 & PIN 4 ALL CONNECTED PIN 11 ALL. CONNECTED PIN 4, 5 & 2 ON J3. DWN 4-16-69	4-21-69	DWJ
F	REWIRED PINS ROUTING BUS3 PIN 11 ON ALL CONN., WIRED ALL PIN 16's GOSNET 5/24/69	5/24/69	DWJ



RACK GRD.
(INSUL. STRANDED WIRE, #18)

SIGNAL GRD.
(BUS WIRE #14 & INSUL.
STRANDED WIRE, #18)

NOTES:

1. CONNECTORS J3 THRU J8 ARE AMPHENOL #26-4200-163

A1

WIRING DIAG.
RACK
MODEL 350 51

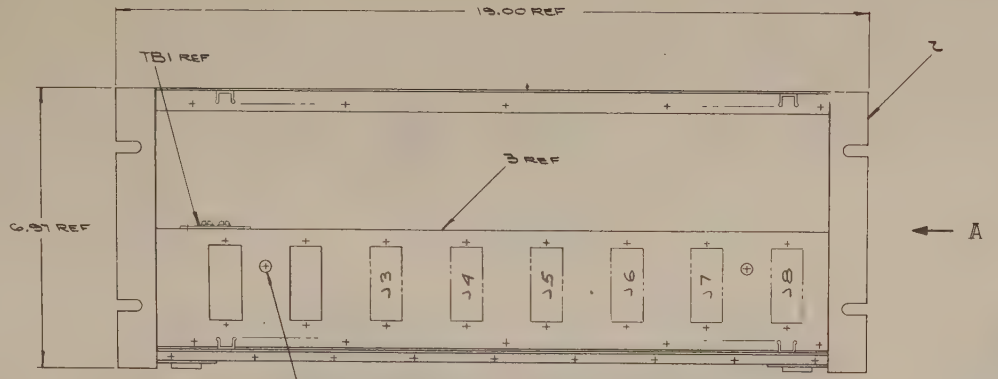
ITHACO, INC.
ITHACA, N. Y.

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON
FRACTIONS DECIMALS ANGLES
± ± ±

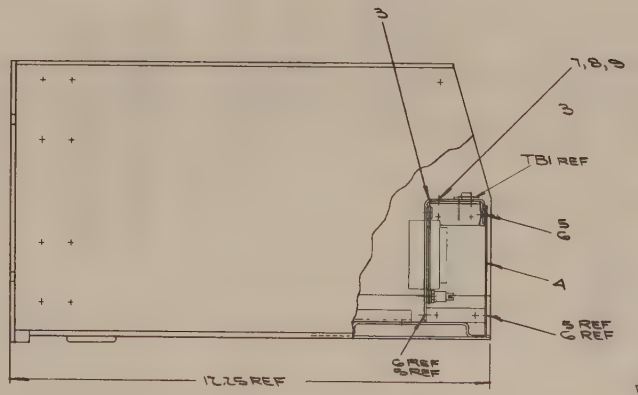
DRAWN BY R. Stevens May 9, 1968
APPROVAL: DFTG. ENG. RZF
ISSUE DATE May 16, 1968

C 30650
CONT. ON SH. F SH. NO. 1

REVISIONS		C 30547 CONT ON SH — SH NO 1
SYM.	DESCRIPTION	DATE / APPROVAL
A	GEN'L CHANGES PER ECN 7-6823, 1968	4/16/68
B	ADDED "PARTIAL REAR VIEW, TBI'S PART IO PER ECN 7-6823, 1968	7/16/68
C	DELETED 2 CONNECTORS, J1 THRU J8 WERE J3 THRU J8; NOTE 2 WAS ... PER C30822	5/11/68
D	NOTE 3 WAS FOR ELEM D-96, SEE B21003 & B21004 PER 5-5-68	5/17/68
E	J3 WAS J1, J4 WAS J2, J5 WAS J3, J6 WAS J4, J7 WAS J5, J8 WAS J6, ADDED 10 PT 10 NOTE 2, PER 9-19-68	9/11/68

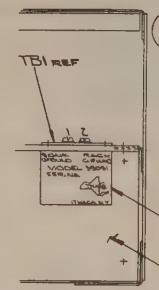


RACK FRONT VIEW-REF



VIEW AT "A"

RACK SIDE VIEW-REF



PARTIAL REAR VIEW

(1) ASSEMBLY

NOTES

1. "J" NO.'S ARE FOR REFERENCE ONLY.
2. PART 3 TO BE ASSEMBLED PER D40355.
3. FOR WIRING DIAG. SEE C30650

SEE SEPARATE PARTS LIST

A3
A1

ASSEMBLY, RACK MODEL 35051

FME 5016-85

ITHACO, INC.
ITHACA, N. Y.

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON FRACTIONS ± DECIMALS ± ANGLES ±

DRAWN BY [illegible] Jan 27, 1967

APPROVAL: DFTG. [illegible] ENG [illegible]

ISSUE DATE December 21, 1967

C 30547

CONT ON SH. F SH. NO. 1

REVISIONS			D 40444 CONT. ON SH. FIN SH. NO. 1	
SYM.	DESCRIPTION		DATE	APPROVAL
A	DELETED S8 & T7 IN D1, ADDED C1 IN D1. S6 IN D1, & J3 IN D1. ADDED S9 IN D1 & J8 & CHGD AC WIRING IN D1 PER E.O. 68-67		Feb 10, 1969	RLF
B	CHANGED R28 IN D1 TO 2.5K, ADDED TO SYNCH SWITCHES, DELETED BOARD OUT IN C1. ADDED R44, CHANGED R8 IN D1, DELETED J4 IN D1 PER E.O. 6-C-28		6-5-69	RLF

B1 - J3
FOR REMOTE PREAMP CONNECTIONS.

REMOTE INPUT, -15V, SIG GRD, +15V, SHLD

INPUT A J1

INPUT B J2

INPUT S2

S4

E1-E6 FOR SIGNAL CONDITIONING COMPONENTS (CUST. OPTION)

FOR EXTERNAL FILTER
IN J4 OUT J5

INTERNAL JUMPER AT BNC

INPUT STAGE
+10 DB
Q1-Q6 INCL.

Z=10K

AMPLIFIER
+70 DB TO -40 DB
IC1-IC3

OUTPUT J6

1502Ω

B1 P1-6 C1 P1-6

X1

X(-1)

SYNCHRONOUS SWITCHES Q40-Q45 INCL.

DET J 3

10K

C1 P1-8 D1 P1-8

S5 LOW LIMIT

10KΩ 100KΩ 1MΩ

OR

ALARM CIRCUIT Q13-Q15

OVERLOAD LAMP

S1 SENSITIVITY 1UV — 300MV

POWER SUPPLY FILTER FOR ALL EXCEPT IC2 & IC3

-15V B1 P1-1 TO D1 (P1-1)
B1 P1-2 TO D1 (P1-2)
+15V B1 P1-3 TO D1 (P1-3)

GATE OUT J4

1K

DRIVER Q38-Q39

REF STATUS C1 P1-13 D1 P1-13

C1 P1-2

TYPE B1
AMPLIFIER

TYPE C1
DEMODULATOR

INVERTER Q44

THRESHOLD DETECTOR IC1 Q10

TRIM R30 (CARD)

REF INPUT J1

100K

31Ω

S1-PHASE

S2-FREQ RANGE

0° 90° 180° 270° OUT

MV1 Q32-Q37 INCL.

MV2 Q11-Q16 INCL.

MV3 Q19-Q24 INCL.

MV4 Q25-Q30 INCL.

IN OUT

SERVO RESET (FROM D1 P1-3)

S1 P1-3

SERVO FOR 50% DUTY CYCLE Q1-Q8 INCL.

BALANCE R2 (PANEL) (CONTROLS SYMMETRY)

INVERTER Q31

+15V

R83 (CARD)

PHASE R1 (PANEL)

R97 (CARD)

S1 OUT

270° 180° 90° 0°

S3

4 24

R106 (CARD)

CAL OUT J2

31Ω

TYPE D1
DISPLAY MODULE

OVERLOAD LAMP

ALARM CIRCUIT

OFFSET R4 (REAR PANEL)

AMP Q6D6 -A1

R5

J5 0-1V OUTPUT

10V OUTPUT J7 (REAR)

D1 P1-16

10V OUTPUT J1 (FRONT)

OUTPUT S5

10 (MAX) 1000

S6 POST DET. GAIN

S4 ZERO SUPR R6

S2 TIME CONSTANT

S3 FILTER RESET

SERVO RESET CIRCUIT

METER S8

REFERENCE FILTER

S1 POWER

FUSE .5A

REGULATED POWER SUPPLY

INDICATOR LIGHT

TB1

WHT BLK

+15V -15V

D1 P1-5 P1-9 P1-1

C1 P1-11 P1-9 P1-7 P1-1

D1 P1-4 P1-2 P1-10

FROM C1 P1-3

FROM CHANNEL 2 OUT

FROM C1 P1-13

115V, 60HZ INPUT

RACK J3-2 J3-10

LINK

MOUNTED ON RACK REAR

NOTE:

⏚ MODULE CIRCUIT GRD

⏚ RACK & POWER LINE GRD

MV1 - MV4, INCLUSIVE, ARE MONOSTABLE MULTIVIBRATORS.

TB1 JUMPERS IN DISPLAY MODULE SHOWN FOR 120V OPERATION. FOR 240V OPERATION REMOVE JUMPER BETWEEN 1 & 2, & 3 & 4 AND ADD JUMPER BETWEEN 2 & 3.

A1

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS ± DECIMALS ± ANGLES ±	FUNCTIONAL BLOCK DIAGRAM BASIC SYSTEM MODEL 353	ITHACO, INC. ITHACA, N.Y.
	DRAWN BY J. Hartley Aug 9, 1968	
	APPROVAL: DFTG. DWJ ENG. FCM	D 40444
	ISSUE DATE Aug 13, 1968	CONT. ON SH. FIN SH. NO. 1